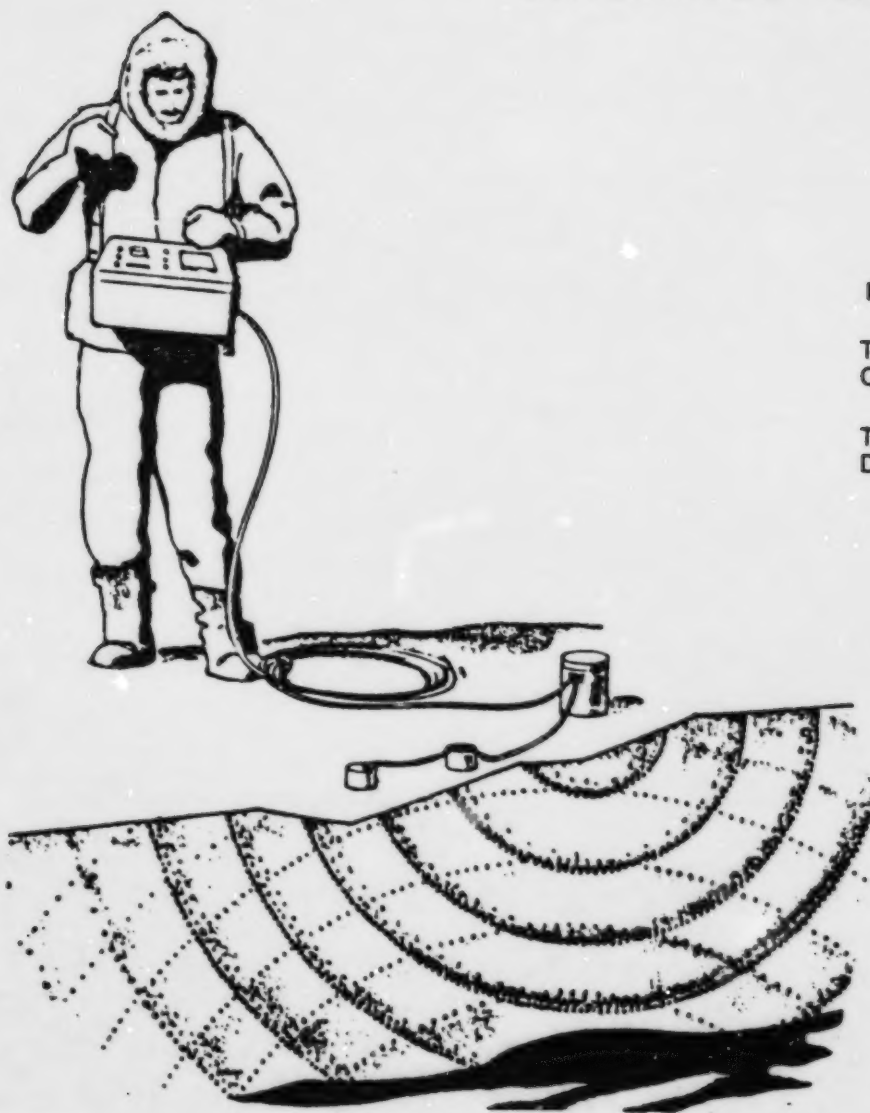


TP6816E

Development of a Portable Ice Thickness Sensor



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DEVELOPMENT AND TESTING OF A
PORTABLE ICE THICKNESS
MEASURING DEVICE

TP6816E
Transportation Development Centre,
Transport Canada.
Contract No.: OSB83-00481

July 1985

by

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17. Abstract The report describes the development of a portable sensor capable of measuring the thickness of a floating ice sheet using an acoustic resonance method. A swept frequency in the audio band is used to excite the ice, and three accelerometers measure the returning signal amplitudes. From the frequency amplitude matrix, a handheld computer calculates the most likely ice thickness and the mean elastic modules of the medium. A series of field experiments was carried out to miniaturize and improve the sensors and electronics, and to develop an extensive software package capable of calculating the ice thickness by filtering, transforming and auto-correlating the data. One of the main objectives was to make the whole device small and portable. This was successfully achieved. Field trials carried out in April 1985 at Resolute Bay showed that the differences in thickness measurements obtained using the resonant acoustic method and the conventional technique of drilling the ice and measuring with a tape were within the experimental error margin of the two techniques (+10 percent maximum). While experiments were confined to ice between 1.5 metres and 2.4 metres, the technique is expected to work through lake or sea ice varying from one to ten metres without modification.			
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17. Résumé Ce rapport décrit la mise au point d'un appareil portatif pour mesurer l'épaisseur des glaces flottantes, fondé sur le principe de la résonance acoustique. On fait varier la fréquence d'un générateur d'impulsions sonores appliqué à la surface de la glace qui deviendra ainsi le siège de vibrations forcées, l'amplitude des signaux de retour étant mesurée par trois accéléromètres. Grâce à la matrice mettant en rapport fréquences et amplitudes, il est possible de déterminer à l'aide d'une calculatrice de poche l'épaisseur probable de la glace ainsi que les modules d'élasticité moyens de celle-ci. Des essais in situ ont été faits dans le but de réaliser un ensemble électronique compact et fiable et d'élaborer divers logiciels capables de faire les calculs nécessaires par filtrage, transformation et auto-corrélation des données. Il fallait réaliser en premier lieu un appareil à la fois petit et portatif; c'est ce qui a été fait. Les essais in situ faits en avril 1985 à Resolute Bay ont montré que les écarts entre les résultats obtenus par la méthode de résonance acoustique, d'une part, et par la méthode classique de mesurage manuel après forage, d'autre part, sont à l'intérieur de la marge d'erreur expérimentale des deux méthodes, à savoir + 10 p.100. Bien que les essais aient été limités à des épaisseurs variant de 1,5 à 2,4 mètres, la méthode préconisée devrait pouvoir être transposée sans modification à la mesure des glaces de lacs et de mer d'une épaisseur variant entre un et dix mètres.			
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SUMMARY

Under the terms of a Service Contract issued by Transportation Development Centre of Montreal, Polar Tech Ltd initially evaluated the technique of measuring floating ice sheets of varying thicknesses (between 0.2 and 20 metres) by using resonant acoustic waves.

In its simplest configuration, an ice-mounted sonic source was excited by a precise frequency within the band 300 - 10,000 Hz, and the reflection amplitudes of the ice sheet were monitored. For a given propagation velocity, the resonant fundamental and subsequent harmonics are directly proportional to the wavelength and hence the ice sheet thickness. Thus, the ice thickness may be determined simply by observing the resonant harmonics.

The project initially evaluated the technique using conventional laboratory electronics. Tests on concrete blocks and water columns were followed by others on lake ice and finally on a 'pseudo' thick sheet of ice in a cold room, designed to appear to the acoustic beam to have no lateral boundaries.

The study, which is described in Transportation Development Centre Report No.: TP4887E "Development of a Portable Ice Thickness Sensor" by Rick D. Hudson and Tim R. Day (Polar Tech Ltd), August 1983, showed that:

1. It was possible to measure sheet ice thickness over the range 0.5 - 20 m with an accuracy of $\pm 10\%$ or less without difficulty.
2. An acoustic-based system provided a small, safe and cheap way to analyse ice thickness.

Under the terms of a new contract issued in November 1983, Polar Tech Ltd undertook to improve the design of the various electronic components, to squeeze them into a portable size, and to automate the data analysis sufficiently that the measurement technique was as simple as possible.

This was done in three stages:

1. The acoustic source and receivers were re-specified, based on previous field experience, and a dedicated controller built which required no adjustments during readings.

2. An intelligent data memory and number cruncher was used both to control the peripheral sensors, and to carry out filtering, autocorrelation and decision branching, so that the operator's input was minimised.

3. A series of field tests was carried out in April 1985 on old and new ice near Resolute Bay, N.W.T., to test and fine-tune the hardware and software.

The results showed that the acoustic method of ice thickness sensing is an effective way of measuring sea ice over the thickness range 0.8 m to 10 m. Measurements in greater ice thicknesses are likely possible, but were not encountered.

Some redesign is still necessary to reduce further the fiddle of setting up the system (delicate adjustments with gloveless hands at -30°C are not practical); the portable computer can now be replaced by a single board processor with adequate data memory and program in ROM (which will save space and make the package slightly smaller than a normal Kleenex box), and the software algorithms can be compiled in machine code to reduce the delay between start and stop, from its present 9 minutes to about 30 seconds.

SOMMAIRE

Aux termes d'un contrat de services signé avec le Centre de développement des transports, Transports Canada, à Montréal, Polar Tech Ltd. a procédé à l'évaluation d'une méthode de mesure de l'épaisseur des glaces flottantes variant de 0,2 à 20 mètres, faisant appel à la résonance acoustique.

Dans sa forme la plus simple, un générateur d'impulsions sonores appliqué à la glace est mis en marche à une fréquence donnée, entre 300 et 10,000 Hz, l'amplitude des signaux de retour étant alors enregistrée à travers la glace. A vitesse de propagation du son constante, la fréquence fondamentale de résonance et les harmoniques de cette fondamentale sont directement proportionnelles à la longueur d'onde de l'impulsion et, donc, à l'épaisseur du matériau. Il devient alors possible de déduire celle-ci par le simple repérage des harmoniques.

La méthode utilisée au départ mettait en oeuvre un appareillage électronique de laboratoire classique. Les essais sur des dalles en béton et sur des colonnes d'eau ont été suivis par d'autres sur de la glace de lacs et, enfin, de la glace fabriquée dans une chambre froide et présentant des caractéristiques telles qu'elle simulait un champ de glace de largeur infinie.

L'étude publiée sous le numéro TP 4887E "Development of a Portable Ice Thickness Sensor" by Rick D. Hudson and Tim R. Day (Polar Tech Ltd.), en août 1983 et soumise au CDT à Montréal:

1. qu'il est possible de mesurer des épaisseurs de glace variant entre 0,5 et 20 m à une précision de 10 p. 100 près ou mieux, sans aucune difficulté, et

2. que l'appareil acoustique préconisé était compact, sûr et économique.

Aux termes d'un nouveau contrat daté de novembre 1983, Polar Tech Ltd. a procédé à la miniaturisation des organes électroniques dans le but de réaliser un appareil portatif, et à la simplification des techniques de mesure par une automatisation aussi poussée que possible.

Cela fut fait en trois étapes:

1. Une nouvelle spécification du générateur et des capteurs a été élaborée à partir des résultats obtenus précédemment, et un organe de commande a été réalisé ne nécessitant aucun réglage entre deux lectures.

2. Un système intelligent comportant une mémoire et un organe de calcul a été utilisé pour piloter les capteurs et pour effectuer les fonctions de filtrage, d'auto-corrélation et de branchement de manière à soulager l'opérateur de toutes ces opérations.

3. Des essais in situ ont été faits en avril 1985 à Resolute Bay (T.N.-O.) sur des glaces jeunes et vieilles pour mettre à l'épreuve tant le matériel que les logiciels et pour les affiner.

Les résultats ont montré la fiabilité de cette méthode dans une gamme d'épaisseurs variant de 0,8 à 10 m. Le mesurage d'épaisseurs plus grandes devrait être possible, mais on n'a pas pu le vérifier faute de glaces ayant l'épaisseur recherchée.

Des perfectionnements restent à faire, notamment pour réduire davantage le besoin de manipulation dans des conditions où le froid (-30°C) ne permet pas d'ôter les gants. Le calculateur portatif peut maintenant être remplacé par un processeur monocarte, doté d'une mémoire suffisante et de programmes stockés en mémoire ROM, le tout dans un emballage un peu plus petit qu'une boîte de papiers mouchoirs. Quant aux algorithmes des logiciels, ils peuvent être réalisés en code machine de manière à ramener le temps total de manipulation des 9 minutes actuelles à quelque 30 secondes, seulement.

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1. APPLICATIONS OF AN ACOUSTIC ICE THICKNESS PROFILER

Historically, there have been only two methods of measuring ice thickness with any degree of accuracy: either the operator drills a series of holes (a slow and laborious process), or an impulse radar system (GSSI, MPB, SPRI or other) may be used (which is large, expensive and ice-type dependent).

Both techniques have been used widely despite their disadvantages, because the thickness of floating ice sheets is perhaps the most fundamental parameter required when operating in the polar regions on ice runways, roads, harbour works and shipping lanes.

In 1977, Dr Rick Hudson became interested in using acoustics as an alternative method to measure ice thicknesses, and from then until 1981 he carried out a series of experiments and analyses to test this hypothesis. Early work centred around high frequency seismics (200 - 1000 Hz), but the work was inconclusive because of the nature of sea ice. Ice is frequently cracked, irregular and erratically crystallised, so that the single shot technique of seismics produced too few solutions to too many unknowns.

In 1982, he therefore turned to the acoustic resonance method, a technique which had been used to good effect in the 1950's in mechanical engineering applications requiring the measurement of steel thicknesses. Its advantages are obvious; since the frequency range is swept slowly, many samples are taken and averaged at any discrete frequency, so that the method does not suffer from the drawbacks of ultra-seismics, where a solution is derived from a single shot.

The same applies to the signal source; because it is continuous, it is simpler to build and operate than a pulsed device. Since the thicknesses are relatively small, return times are very short (typically less than a millisecond), requiring specialised equipment to record one-shot techniques. With a continuously emitting source, however, this requirement is not necessary, and the hardware benefits from the simplicity of design.

2. THEORETICAL ASPECTS

The velocity of a longitudinal wave depends upon the dimensions of the specimen in which the waves are travelling. If the solid is a thin bar of finite cross section, then the analysis for longitudinal waves is the same as for a gas, except that the bulk modulus of the gas is replaced by the Young's modulus Y , the ratio of the material's longitudinal stress to longitudinal strain.

The wave equation may then be written :

$$\frac{\partial^2 \eta}{\partial x^2} = \frac{1}{c^2} \cdot \frac{\partial^2 \eta}{\partial t^2}$$

where the wave velocity $c = Y/\rho$.

A longitudinal wave in a medium compresses that medium and distorts it laterally. Because a solid can develop a shear force in any direction, such a lateral distortion is accompanied by a transverse shear. The effect of this on the wave motion in solids of finite cross section is somewhat complex; in bulk solids, we may treat the longitudinal and transverse waves separately.

The ratio of the transverse stress to the transverse strain replaces the elasticity component in the propagation of pure transverse waves in a bulk solid, which Young's modulus plays for longitudinal waves in a thin specimen. The effect of this transverse rigidity is to stiffen the solid and increase the elastic constant governing the propagation of longitudinal waves. The elasticity is increased by an amount equal to Lamé's elastic constant λ (for ice, where the Poisson ratio is 0.3), so that longitudinal waves in a bulk solid have a higher velocity than the same waves along a thin specimen. Compounded to this effect is the characteristic increase in density of deeply layered materials such as glacial ice, which will also result in an increase in the wave velocity with depth. Bennett and Bentley (1965) found this to be the case in Antarctic ice sheets, where the propagation velocity was related to the bulk density by the relationship:

$$V(\rho) = 3250 \times \rho$$

where $V(\rho)$ was in m/s and ρ in gm/cc. See Figure 1.

There appears, also, to be a relationship between compressional wave velocity in ice and the presence (or absence) of brine within the solid. Work by Brown (1958, 1959, 1961), Bogorodskii (1958) and Kohnen (1972) all showed some evidence of the phenomenon, as is illustrated in Figure 2, which is a composite put together by the author. However, there are a number of grey areas with regard to the brine volume estimation. A variety of methods exist to derive the brine content, rather than

COMPRESSIONAL WAVE VELOCITY AS A FUNCTION OF DENSITY
(ALL MEASUREMENTS AT -10°C, VERTICAL DIRECTION ONLY)

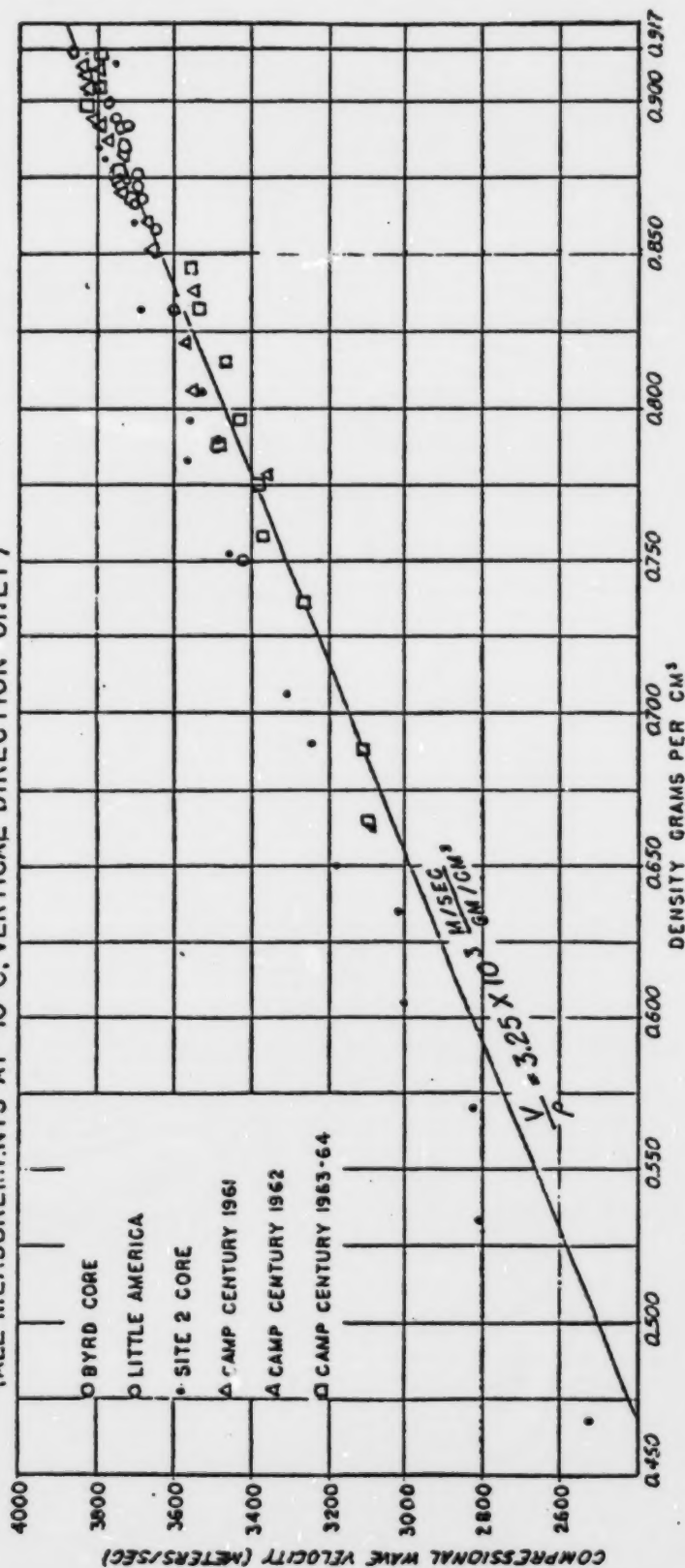


FIGURE 1. Graph of wave velocity in ice versus density.
Graph showing the relationship between the compressional wave velocity of sound in ice and the ice's density, for a number of non-saline sites in Antarctica (after Bennett & Bentley 1965).

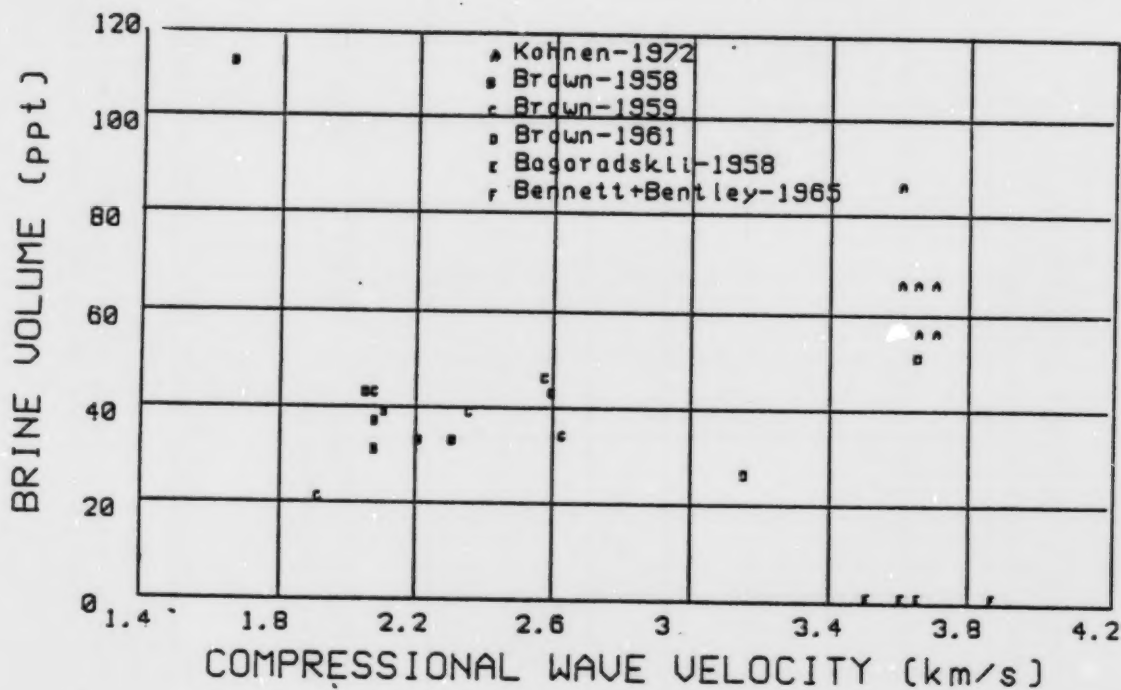


FIGURE 2. Graph of wave velocity in ice versus brine volume.

Graph showing the work of several researchers who have investigated the relationship between the compressional wave velocity (P wave) in ice and the brine volume. Neglecting the non-saline readings of Bogorodskii (1958) and Bennett & Bentley (1965), there may be a first-order linear relationship between wave velocity and brine volume.

the salinity of a sample, and the researchers seldom specified which technique they used. In addition, it is likely that the salinity was not considered to be of much significance, so that it may have had further errors introduced at the time of sampling. We have chosen to illustrate the wave velocity with respect to brine volume because it takes into consideration the temperature at the time of the test:

$$\text{Brine volume } B = S (45.917/T + 0.93)$$

In addition to the variation in wave velocity with dimension (bulk or thin section), density (from snow at the top to hard ice at the base of a glacier), and salinity/brine volume, research has shown acoustic wave propagation through a crystalline structure such as ice exhibits first and fourth order attenuation characteristics. Bogorodskii (1958) noted two effects: he successfully identified the elastic hysteresis phenomenon and deduced from the Stokes-Napier equation that it was frequency dependent, but he was unable to explain the Rayleigh scattering (which he described as heat losses) because of limited data at the time.

However, his work laid the foundation for the use of ultrasonic pulse techniques to determine ice thickness, by Anderson (1958), Brown (1962), Pounder and Langleben (1970) and others. Prentiss et al (1965) carried out a series of field tests to determine the sound spectrum of floating ice sheets in their natural state. This permitted background levels to be established based on the dynamics of the area under study, and showed that much of the acoustical energy is retained in the seismic band of 0.1 - 100 Hz. This led to work by Nevel (1968) on the characteristic vibrations of floating ice sheets. He found that the critical frequency was small and that the amplification of the stresses at this frequency to be low.

Talibouet (1975) studied the effect of plastically deforming ice on the wave velocity, and noted that the attenuation increased with the deformation. His other contribution was the use of methyl-4-1-pentane as a coupling medium between ice and transducer, a technique which was used by Kurfurst (1976) to study ultrasonics in permafrost soils.

The determination of precise attenuation in homogeneous lake ice and its relationship was calculated by Westphal (1965) to be a first and fourth order function of the form:

$$\text{Attenuation } A = 4.5 \times 10^{-2} f + 2.2 \times 10^{-4} f^4$$

where the attenuation is in dB/m and the frequency in kHz. This is shown graphically in Figure 3 and illustrates vividly that at near-audio frequencies the attenuation losses within a bulk ice sheet will be only slightly affected by path-length. As will be

shown, more than 80% of the energy in a transverse wave is lost at the ice:water boundary. Power levels when sounding in either thick or thin ice are therefore much the same.

Field investigations carried out by Langleben (1929) and Langleben and Pounder (1970) confirmed these findings, subject to better definition of the ice type being investigated. Attempts to use this characteristic to measure ice thickness using pulsed waves were only marginally successful because of the complex returns. Vance (1972) tried to overcome this by using the slower, better reflected shear waves: Hoare (1981) tried a beam focussing device. Neither was very effective.

When a planar sound wave meets an acoustic boundary separating two media normally, part of the wave is transmitted through the boundary and the remainder is reflected back. If the wave approaching the boundary does so through a solid having an acoustic impedance $R(1) = p(1) \times c(1)$ where $p(1)$ is the material's density and $c(1)$ its wave velocity, and part of the wave is transmitted into the new medium with $R(2) = p(2) \times c(2)$, then the displacement of the incident wave $y(1)$ is:

$$y(1) = A(1) e^{j\omega(t - x/c(1))}$$

and the reflected wave's displacement:

$$y(2) = B(1) e^{j\omega(t + x/c(1))}$$

The reflection coefficient has an amplitude $= B(1)/A(1)$

The transmission coefficient amplitude is $= A(2)/A(1)$

In terms of energy, the total energy in the wave for ω the wave frequency is:

$$E = \frac{1}{2} \rho \omega^2 A$$

$$\text{Therefore, } \frac{\text{reflected energy}}{\text{incident energy}} = \frac{(R(1) - R(2))^2}{(R(1) + R(2))^2}$$

$$\text{And, } \frac{\text{transmitted energy}}{\text{incident energy}} = \frac{4 R(1). R(2)}{(R(1) + R(2))^2}$$

At an infinite impedance change (as in free space), all the energy will be reflected, with a 180° phase change occurring in the amplitude.

Solution of the wave equation shows that for a standing wave condition (resonance):

$$\begin{aligned} y &= A e^{j\omega t} (e^{-j\omega(\frac{x}{c})} - e^{j\omega(\frac{x}{c})}) \\ &= (-2j) A e^{j\omega t} \sin(\omega x/c) \end{aligned}$$

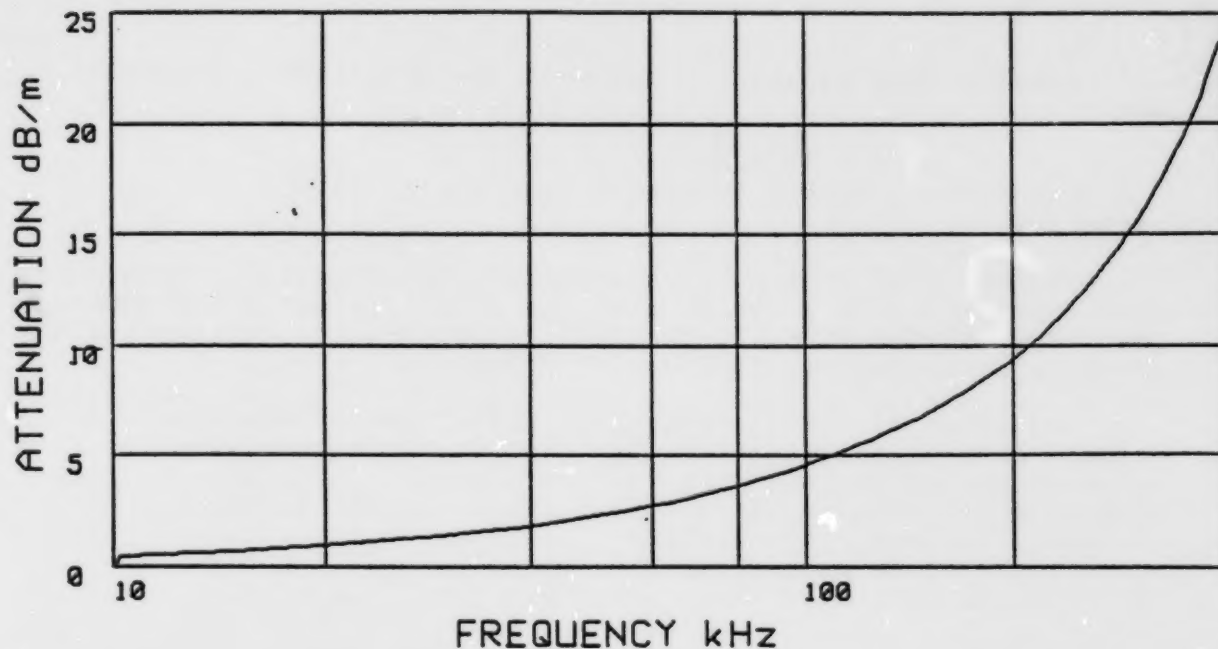


FIGURE 3. Graph of sound velocity in ice versus frequency.

The relationship between the frequency of sound and its attenuation in ice may be written as a fourth-order polynomial. Note that at low frequencies, the attenuation is therefore nearly linear due to hysteresis effects, while at higher frequencies the attenuation increases as a fourth order power due to Rayleigh scattering.

Solving this equation shows that the permitted frequencies are:

$$\omega(n) = n\pi c/l$$

where $n = 1$ is the fundamental, and $n = 2, 3, \dots$ are the harmonics.

Notice that if the acoustic impedance of medium 1 is greater than that of medium 2 (as in the case of an ice:water interface), then the incident particle velocities are in phase, but the acoustic pressures are 180° out of phase.

Hudson et al (1983) noted that almost 90% of the energy of a normal wave travelling through sea ice is transmitted into the water below, while only 10% is reflected. This was to their advantage provided sufficient energy was coupled to the ice at the surface, because it permitted spurious harmonics and complex reflections to be damped rapidly, allowing only the pure tone or harmonics to dominate, since these are continuously being updated.

By the same law, nearly 100% of the energy in the ice is reflected at the upper ice:air boundary.

3. EQUIPMENT.

Calculations show that to set up resonant waves in an ice sheet having an average compressional wave velocity of 3200 m/s and varying in thickness between 0.5m and 20m, it is necessary to have an acoustic system capable of delivering an output over the frequency range 150-12,000 Hz. Such systems are readily available since that is the prime hi-fi range. Problems did arise, however, in the choice of an acoustic source.

3.1 The Acoustic Source.

Various loudspeakers and transducer systems were investigated. A prime criterion was that the unit should deliver a minimum of 20 watts rms and that its response was flat over the frequency band of interest. Additional conditions were that the device be rugged (which ruled out commercial moving-cone devices), capable of being immersed in water (which ruled out electrostatic speakers) and be relatively portable (which excluded the use of piezo-crystals).

A variety of devices were used over the period of 2 years, and we finally settled on a moving coil underwater speaker built by University Sound, Model No.: UW-30, having 30 watts rms output. See Figure 4. Field experiments revealed further advantages: it did not need to be back-filled with oil or water to damp the out of phase waves, nor did it need a specially shaped hole in the ice to improve coupling (although this may be an option in ice over 10m in depth).

Experiments showed that the speaker could be placed on the ice's top surface (after the snow has been cleaned off with a shovel), and a little fresh water from a thermos flask poured onto the ice around it. Provided the air temperature is cold, the UW-30 bonds to the ice rapidly for the duration of the trials, and can be snapped off afterwards without problems.

Details of the UW-30 may be found in Appendix II, Hardware Specifications.

3.2 The Acoustic Receivers.

Early work on the project had shown that high frequency geophones like those in Figure 5 (Mark Products, Houston, TX, model No.: L-40) were cheap but had poor response above 2300 Hz. We therefore chose a low mass accelerometer from BBN Model No.: 508



FIGURE 4. University Inc. speaker model UW-30.

Photograph of a University Inc. underwater speaker Model UW-30. The unit weighs less than a kilogram, is mounted in an impact-resistant case, and uses a non-corroding moving coil to deliver 30 watts rms maximum continuous output ± 2 dB.

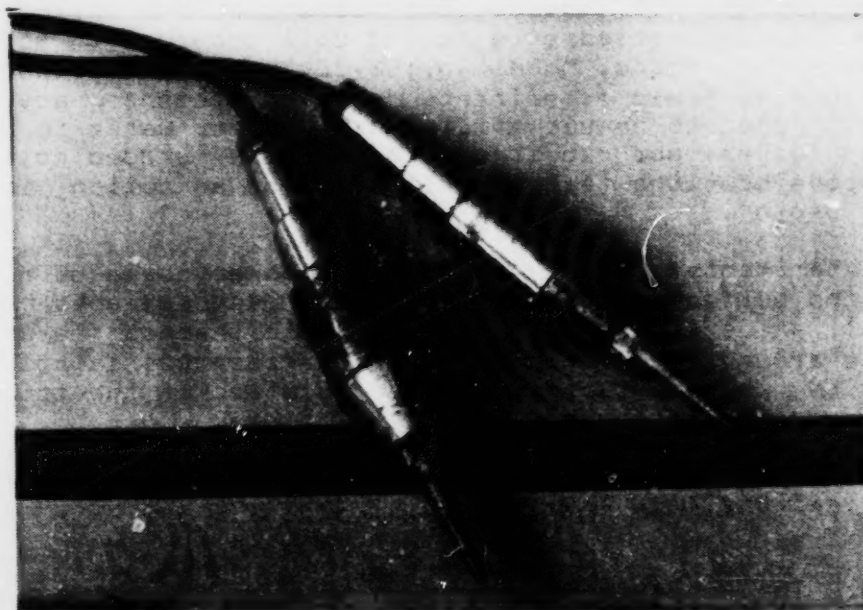


FIGURE 5. Mark Products Ltd high frequency geophones.

Detail of two Mark Products Ltd high frequency geophones, Model L-40. While proving to be very rugged and economical, their use is limited to very thick ice sheets only.

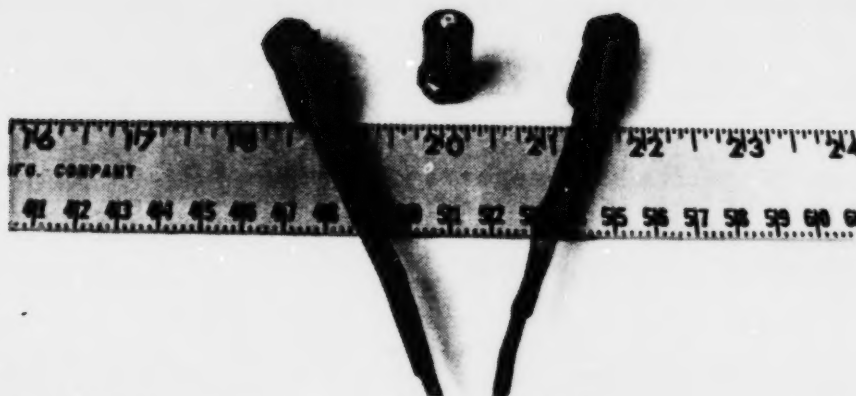


FIGURE 6. Vibrotron BBN Model 508 accelerometers.

The Vibrotron BBN Model 508 accelerometers proved to be the most effective at detecting resonant harmonics when bonded to the ice's top surface. The central unit shows their small size. Left and right units are grease-packed and taped prior to use.



FIGURE 7. Husky portable computer.

A Husky computer was used as the data processor and recorder for the field trials. Having 48K of onboard RAM and a further 32K of operating ROM, the Husky is a small, light, water-tight processor capable of running sophisticated algorithms.

which offered a flat response over the range of interest (first mass resonance was at 40 kHz, giving a smooth 100 - 15,000 Hz plateau) with acceptable sensitivity (10 mV/g). Because of their high cost, only 2 were used, and it was found that when using the UW-30 at its half power point, there was still adequate signal-to-noise.

For the latest trials, three BBN Model No.:501's were acquired (Figure 6). Cheaper and more versatile, they had an added advantage of having the cable output from the top of the sensor, increasing their waterproofness in the high splash and corrosion environment of on-ice work.

The use of three sensors compensated for surface wave effects, and it was found that the sum of the returning signals was not influenced by the relative positions of the accelerometers. Each unit was bolted onto a thin disk of metal (ends of food tins were used in the field) to improve freeze/bonding to the ice, and they were then randomly frozen to the ice's surface using a little fresh water from a thermos flask. The low mass of the added disks did not appear to influence the top end response of the accelerometers, and helped to reduce further any Love and surface wave interferences.

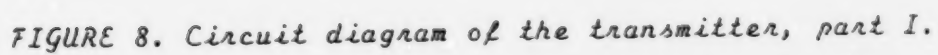
A screwdriver was used to pry them off after each test.

3.3 The Transmit Circuit.

Timing for the interface electronics and filters was derived from the handheld computer "Husky", shown in Figure 7. During an acoustic sweep, the NSC800 cpu in the computer sends a 256 incremental binary count via the 8 line port to the PTL interface card. By setting the rate of count, the sweep time is controlled in software. On a point of interest, it was found that data measured from a sweep taking 5 seconds was very nearly as clean as that from a 20 second sweep, without the obvious disadvantage of waiting an extra 15 seconds in the cold.

The binary count is converted via a digital to analog converter into a staircase voltage ramp (Figure 8), which is used to drive a voltage controlled oscillator (Figure 9). Thus the binary count produces a swept frequency over the range of interest.

Because of noise considerations (future models will almost certainly work in close proximity to trucks, helicopters, heavy machinery etc), very tight filter tracking was built into the system to improve the signal-to-noise ratio. The only low power method of sweeping a filter involves the use of National Semiconductor's MF10 chip. While the device is an excellent



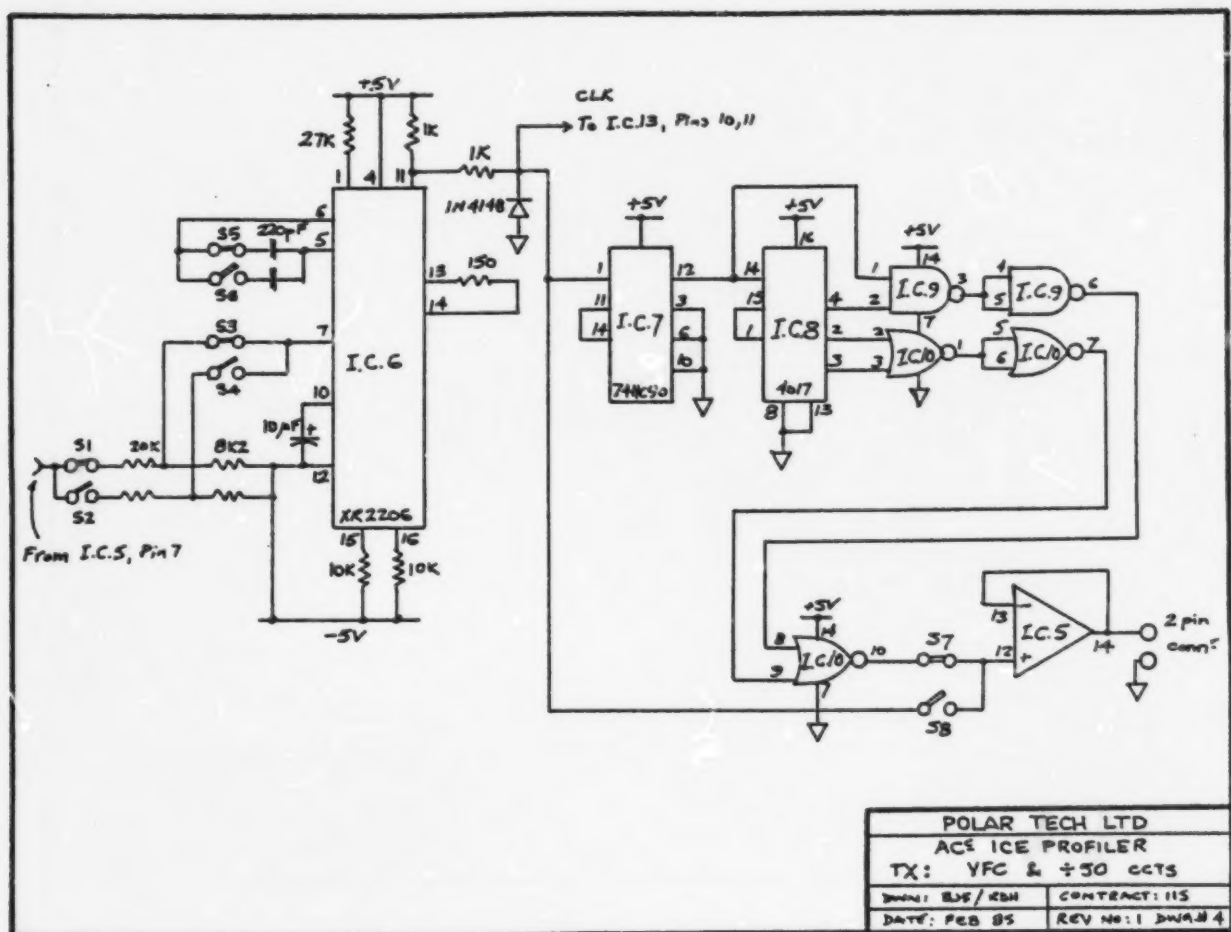


FIGURE 9. Circuit diagram of the transmitter, part II.

advance over previous technology, it requires a clock frequency which is exactly 50X the frequency of interest. Thus the top acoustic frequency of 10 kHz meant that the oscillator needed to produce a top frequency of $50 \times 10 \text{ kHz} = 500 \text{ kHz}$.

This high tone was then divided down, filtered to a pure sine wave, and fed to the power amplifier. In the interests of size and weight, a 20 watt rms 12 volt P.A. amplifier was used. Very compact (for normal car use), its output was adequate for all the ice types encountered, but may limit the unit in ice greater than 10 metres. The power out and on/off switches were the only 2 controls on the system which were not software controllable.

3.5 The Receive Circuit.

The returning signals from the three accelerometers were fed via independent charge amplifiers on a separate board (to facilitate future design changes) to a summing amplifier. See Figure 10. The combined signal was filtered using a tracking filter with a Q of 100+, and then connected to an RMS-dc converter. Because of the very clean return signal (after filtering), the crest factor at the converter is close to unity, ensuring a meaningful result at its output. This dc level, which is effectively the envelope of the returning signal, is fed to an analog to digital converter (Figure 11).

The Husky sequentially sets a latch to drive the output stage at a fixed frequency, then looks at the digitized value of the returning signal's envelope, and stores that number in memory, before repeating the process at the next higher frequency step.

3.6 The Computer/controller.

Control of the sweep, and collection of the samples, is achieved using a 48K RAM and 24K ROM "Husky" computer, which is shown in Figure 12. Chosen for its small size and ruggedness (it is waterproof), the Husky offered a QWERTY membrane keyboard, small LCD screen, memory, BASIC operating system and 8-bit parallel I/O in one package. Its relatively high cost was offset by its versatility and speed at which the controller software could be developed and tested.

Limitations which were encountered during the development stage were (1) it works only in double precision (there is no integer logic), and (2) Husky BASIC does not support either power or exponential mathematics, making auto-correlations and Fourier transforms slow and complex.

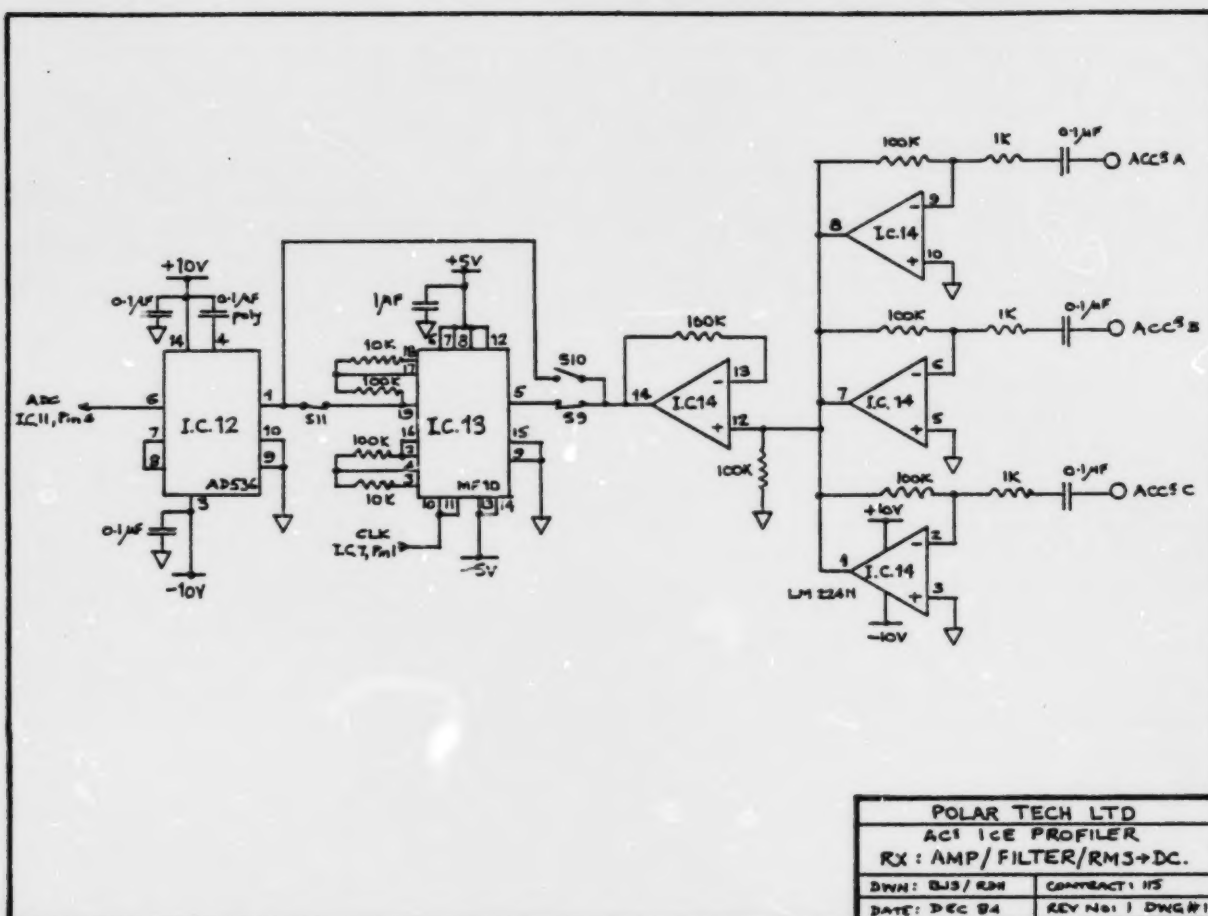


FIGURE 10. Circuit diagram of the receiver, part I.

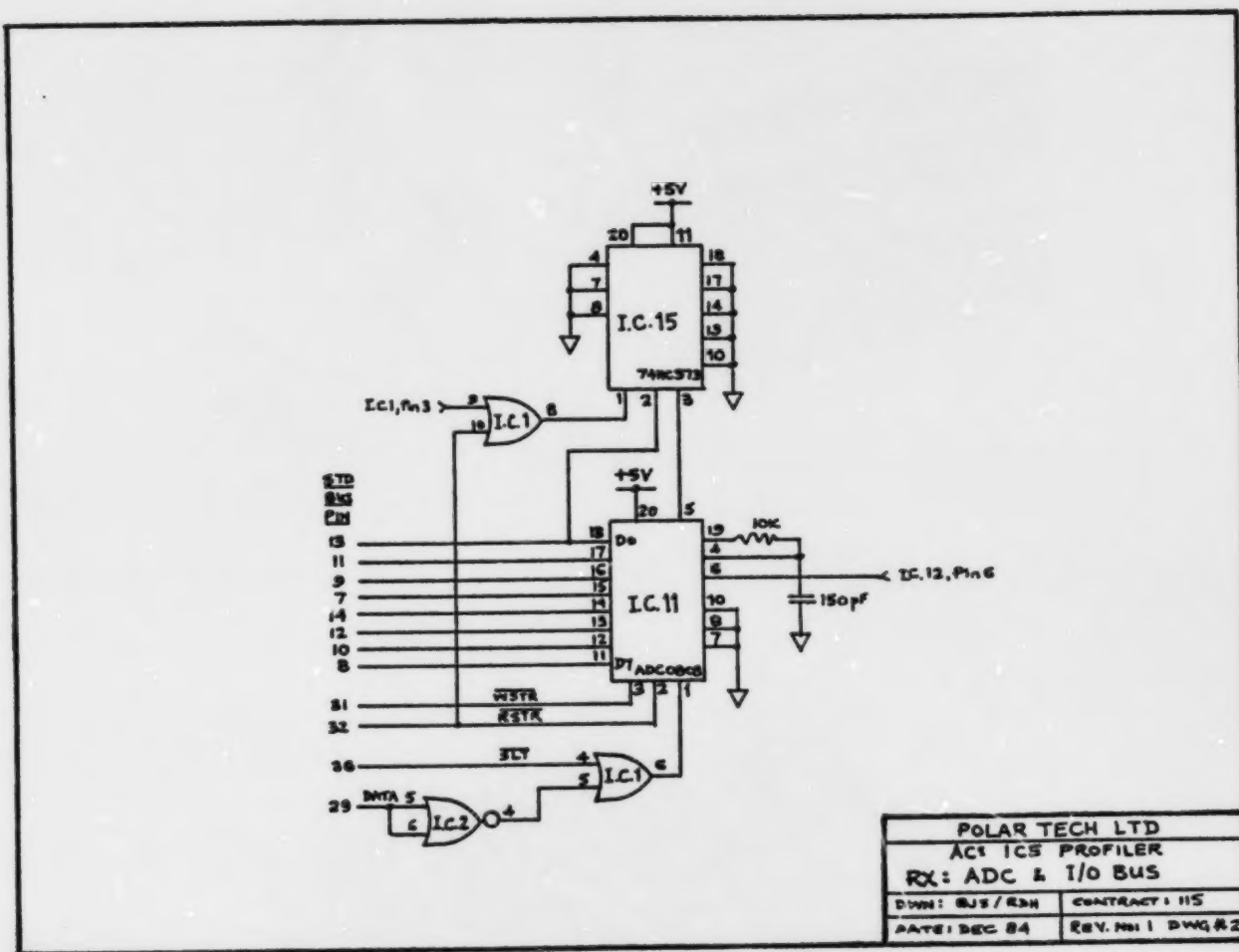


FIGURE 11. Circuit diagram of the receiver, part II.

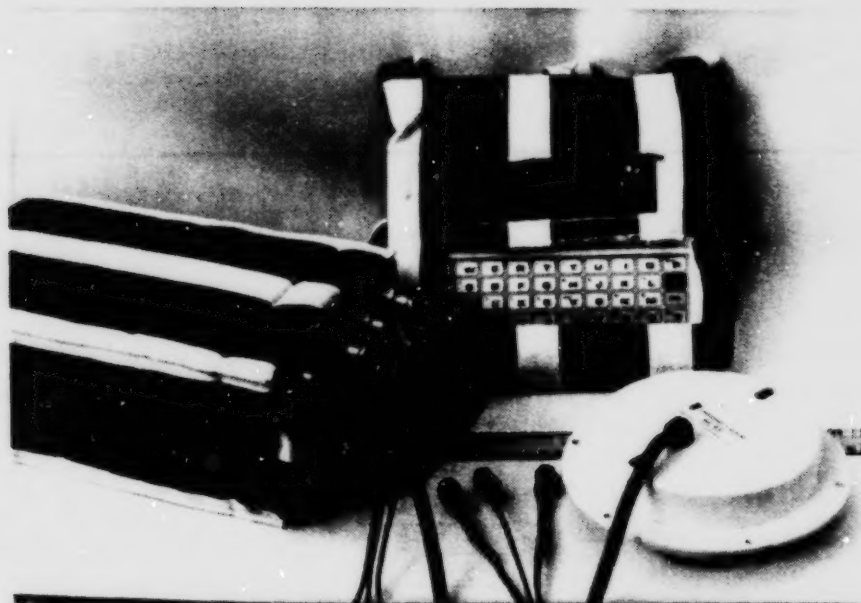


FIGURE 12. System used to determine ice thickness.

Photograph of the field system used to measure ice thickness during the field trials at Resolute Bay in April 1985. At centre, the Husky computer controls the interface system (left) which housed the batteries and electronics needed to drive the sensors on the ice surface.

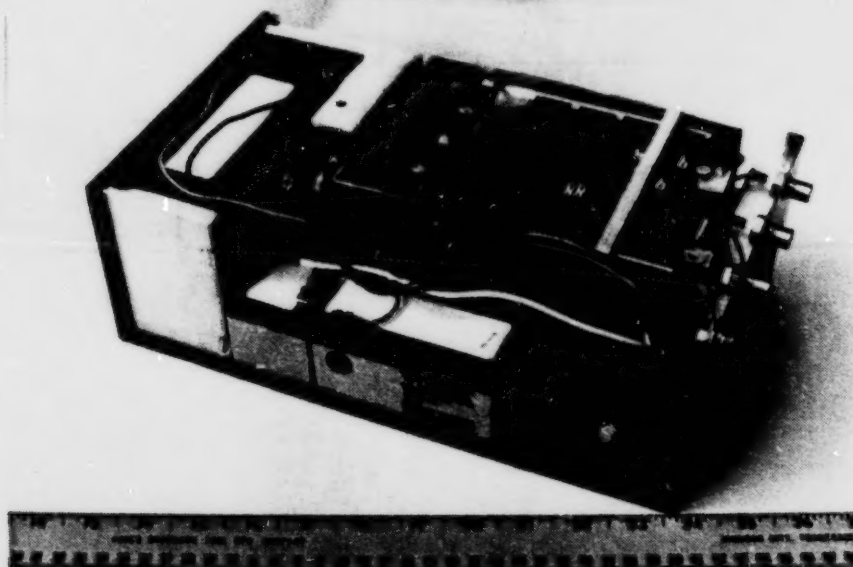


FIGURE 14. Interface between computer and sensors.

Detail of the interface unit between the sensors and the computer. The large battery (left) drives the 20W power amplifier (under the boards on the right). The near batteries supply power to the interface boards (upper right). Future designs will include a microprocessor board, and removal of the large battery and external Husky computer, for a smaller package.

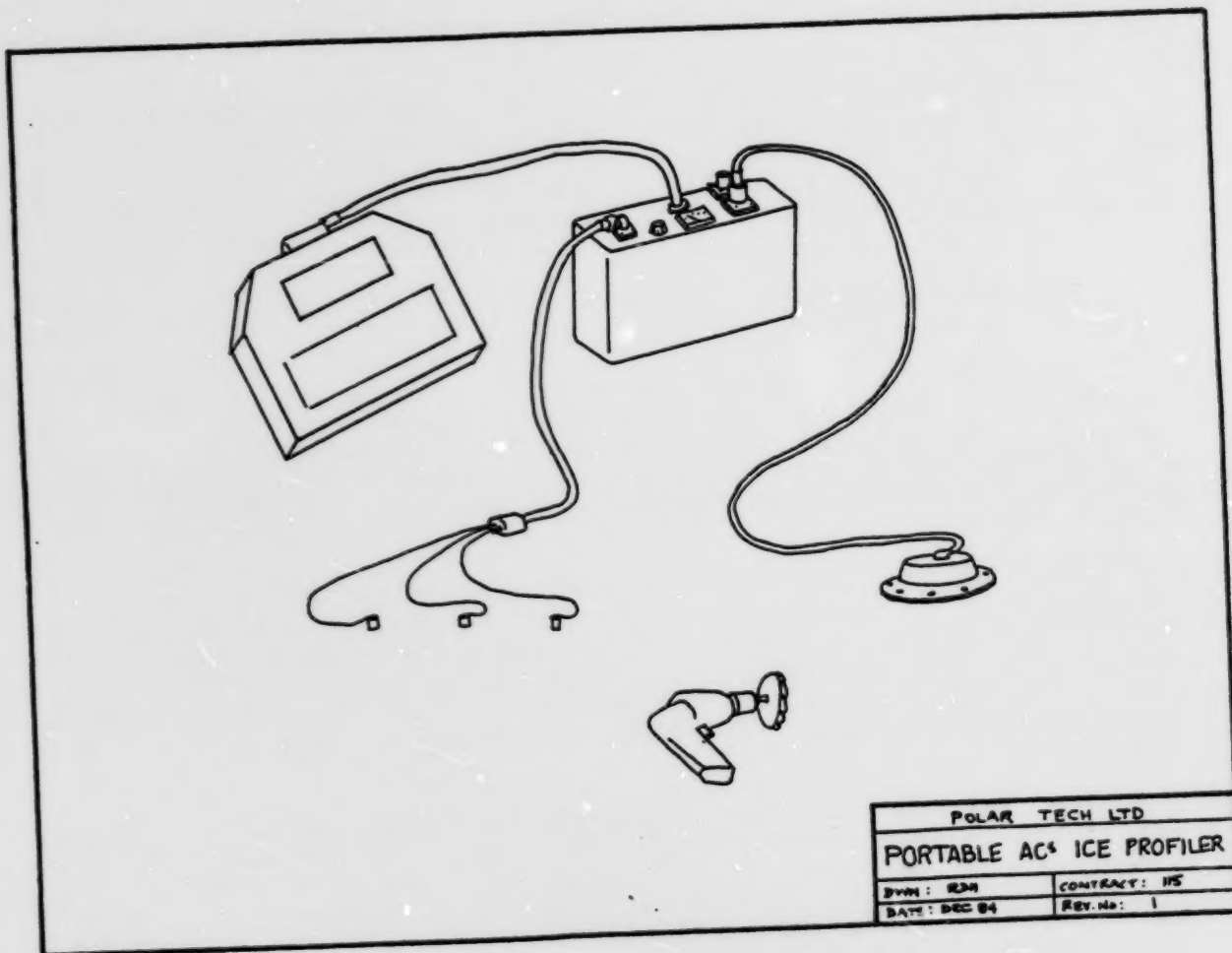


FIGURE 13. Diagram of portable acoustic ice profiler.

Diagram of the unit as used in the field. The Husky computer (upper left) controls the logic and power unit (upper right) via an 8 bit parallel bus. The swept signal is amplified and sent to the speaker (lower right) which drives the ice sheet acoustically. A battery-driven hand drill with an ice cutter attachment (lower center) may be used to improve the ice: speaker coupling for thick ice sheets. Resonant waves are detected by the three accelerometers on the ice (lower left), amplified, filtered, digitized and fed back to the Husky computer, which stores the relative amplitude for a stepped frequency. Subsequent processing performs auto-correlations on the data field and determines the best estimate of the ice's thickness and elastic modulus.

Specifications for the Husky computer are included in Appendix II.

Future controllers will be of the dedicated single board type, since they will not need the flexibility of a keyboard input and multi-line screen. This will mean lower cost, a smaller package and greater reliability due to the reduced number of interconnecting cables between sections.

3.6 The Software.

Purpose: To analyse acoustic signatures and determine the fundamental frequency and overtones present. The analysis procedure allows for the use of FFT processing, filtering, correlation analysis and linear interpolation of original data. Printing, plotting and saving of data to disk are all incorporated.

This program was written originally to assist with the determination of fundamental acoustic frequencies in a number of acoustic signatures. These signatures were collected both under controlled (i.e. laboratory) and field conditions. The quality of data available in these signatures varied from being almost directly interpretable, to being difficult to analyse by any procedure.

The initial approach taken in this work was to filter the signatures by some mechanism to sharpen peaks in the spectrum and therefore allow for a more accurate determination of the fundamental acoustic frequency. The FFT process and certain accompanying filters were applied to several of the signatures. Improvements in the determinations of fundamental frequencies were minimal.

Further investigations lead to the proposal to apply a correlation analysis technique to these acoustic signatures. At this point, with the problem of a growing complexity of information management, it was decided to write a somewhat more flexible and elaborate program to incorporate all the required facets of data processing required for this project. In addition, future developments and/or modifications would be much more readily incorporated into the work.

To allow for future additions to the program and to use current structured programming techniques, the program is written as a number of discrete code blocks. Each code block logically corresponds to a single analytical function or process. New processing facilities can be added by writing and debugging them externally to the main program and then adding the virtually completed code to the current program.

3.6.1 Fast Fourier Transform

The FFT algorithm was left completely intact and functional in the final ACANAL program (ACoustic ANALysis) for future potential use. It is incorporated exactly as presented (Emerson, P. L., Creative Computing, July 1980) in a form specifically written for microcomputers of limited processing capabilities. The FFT can be done in both the forward and reverse directions with compensation for the change in magnitude of data values as explained in the original article.

In addition to the FFT process, a number of different data filters were also incorporated into the program. These include the elimination of user selected components, the elimination of components based on a minimum amplitude criterion and the application of an exponentially rising or falling function to the full data set.

3.6.2 Correlation Analysis

Correlation Analysis as incorporated in this program involves the correlation of data with itself. That is, a given set of data points representing the variation of some parameter, such as frequency in this case, over some interval, can be examined by comparing the original data with a copy of itself shifted by some arbitrary frequency offset.

In the case of these acoustic signatures, the correlation coefficient should go through a maximum as the frequency by which the two signatures differ goes through a fundamental frequency or overtone present in the original data.

The equation used to calculate the correlation coefficients for given offsets is:

Note that both the application of FFT based filtering and the use of correlation analysis require that the data being analysed be uniformly spaced. This led to the inclusion of a simple linear interpolation algorithm to allow the operator the option of ensuring that the data was uniformly spaced if necessary.

3.6.3 Program Outline

The program was written to coordinate the use of a group of

independent routines in such a way as to give the operator as much freedom as possible in selecting the sequence of operations to be applied to a given data set. Since a complex series of operations is possible, the main menu screen was designed to help remind the operator which operations had been completed.

To simplify the use of this program further, it is designed to read any required data from the designated floppy disk file into a temporary holding array. A second series of arrays are used for carrying out all required calculations. This means that if the user makes a mistake during processing, the processing arrays can be quickly reloaded from the holding arrays rather than having to wait while the data is re-read from the floppy disk file.

Each of the program section descriptions indicates which key variables must be supplied to call the subroutine. The values returned will also be listed.

The many menus which appear throughout the program are largely controlled via direct cursor addressing. While this does present a good mechanism for controlling the screen layout, it was incorporated in a manner which is somewhat dependent on the number of data description fields to be placed on the screen. This means that if a new field is to be added to a particular screen, the number of data fields read and their placement on the screen must be corrected. This correction will have a cascading effect through the remaining screens in the linear sequence of the source code. This phenomenon results from the use of specific numbers rather than relative variables for reading data statements and locating text on the screen.

4. EXPERIMENTS AND RESULTS.

Early field trials were described in TDC Report No.: TP4887E. Later trials, principally on frozen lakes in Alberta, are not described here since their results, while interesting, are less informative than the latest series of tests carried out at Resolute Bay, N.W.T. in April 1985.

Because of the high degree of portability of the newly configured equipment which is shown in a sketch in Figure 13, Rick Hudson was able to travel freely by skidoo through the ridged shore zone ice, and work in the multiyear pack on a daily basis. Everything needed for the tests could be packed into a cardboard box which balanced between the knees on the gas tank. With the inclusion of a dedicated microprocessor inside the controller box, the size can be further reduced.

Once at a chosen sight, the snow was shovelled away, revealing bare ice. The sound source and the three accelerometers were frozen to the ice using a splash of water from a thermos flask; a minute was spent waiting for the water to freeze, and a set of 5 readings were taken. Because the processor took 9 minutes to perform all the calculations (future models will do this in less than a minute), only one complete calculation per 5 tests were done. The other 4 readings were simply stored for processing back in the warmth of base camp.

Technical difficulties and modifications to the software occupied several days. On a point of interest, the Husky computer continued to work at -35°C for periods up to 9 hours away from base camp, although the screen became very sluggish after an hour of exposure to the cold.

The results of the final field day's work are presented in Table 1. They summarise the method used to obtain true ice depth. In all, 33 readings (or acoustic sweeps) were made over the period of 6 hours. Moving to a new site, setting up the system, freezing the devices onto the surface, taking the readings, getting one result plus 4 back-up samples, packing up, hand drilling to confirm the acoustic results, and moving on to another site generally took about an hour, with most of the time spent drilling or skidooing.

Table 1 uses only two values for the acoustic velocity of sound in ice. For the older multiyear ice (tests 1 - 29) a value of 2700 m/s was used. For the lake ice, (tests 30 - 34), 3600 m/s was used. This is in agreement with Figure 2.

Within the multiyear ice types, there are variations in acoustic velocity. However, for simplicity, and for the level of precision needed here, a constant was derived as follows:

TABLE 1
Summary of Results
Acoustic Ice Thickness Field Tests

Test No.	Single Correlation				Double Correlation				Meas'd
	Resonance	Vp	n	Depth	Resonance	Vp	n	Depth	Depth
<u>Multi-year ice:</u>									
3E	1265	2700	2	1.05	1250	2700	2	1.07	1.35
	2600				2500				
	3940				3860				
	Fundamental: 1293				1262				
9E	810	2700	2	1.69	730	2700	2	1.77	1.75
	1590				1590				
	2530				2320				
	3040				3020				
	3910				3810				
	Fundamental: 798				763				
10	740	2700	2	1.76	740	2700	2	1.76	1.75
	1570				1550				
	2170				2340				
	3180				3120				
	3960				3820				
	Fundamental: 767				768				
20	930	2700	2	1.43	1070	2700	2	1.38	1.55
	2760				2680				
	3940				3900				
	Fundamental: 945				979				
25	970	2700	2	1.39	910	2700	2	1.52	1.55
					1700				
					2600				
	3070								
	3700				3700				
	Fundamental: 972				888				
27	1510	2700	2	1.64	1580	2700	2	1.61	1.61
	2550								
	3450				3560				
	Fundamental: 822				840				

TABLE 1 (cont)

Test No.	Single Correlation				Double Correlation				Meas'd
	Resonance	Vp	n	Depth	Resonance	Vp	n	Depth	Depth
<u>Freshwater ice:</u>									
31	810 1700 3880	3600	2	2.22	890 3840	3600	2	2.20	>2.00
Fundamental:	812				829				
33	990 1810 3420	3600	2	1.96	920 1600 3700	3600	2	2.04	>2.00
Fundamental:	917				881				

Three ice depths were calculated acoustically at the start of the day on the sea ice. A likely acoustic velocity 'V(assumed)' was used, and the average ice depth 'd(calculated)' derived using the Husky software. A test hole was then drilled to determine 'd(true)'. Then from the equation

$$V(\text{true}) = \frac{V(\text{assumed}) \times d(\text{true})}{d(\text{calculated})}$$

the true acoustic velocity 'V(true)' prevailing at that time was calculated. For simplicity, this value was used for the remainder of the day. It is likely that different ice types or temperatures will change this value, and that it should be updated periodically during the day. Of course, each update requires a hole to be drilled, which is time consuming.

Lake ice, having less impurities, consistently has a more stable acoustic velocity value. The choice of 3600 m/s was based on other research (Figure 2) and the work done the previous year on the same lake at the same time of year.

Detailed analyses of the various tests are given in Appendix III, along with graphs of autocorrelations etc. Since each test generates a lot of paperwork, the number of analyses presented in this report has been kept to a minimum.

In each test, the resonance frequencies are calculated and listed in columns, firstly for the single correlation process, and then for the double correlation. The assumed acoustic velocity is 2700 m/s for sea ice, 3600 m/s for freshwater. At the bottom of each resonance column, a fundamental frequency is shown for the resonances listed just above. For example, in Test 3E, the single

correlation process detected peaks at 1265, 2600 and 3950 Hz. The fundamental is calculated as $(1265/1 + 2600/2 + 3950/3)/3 = 1293$ Hz. Similarly, the double correlation process deduced values of 1250, 2500 and 3860 Hz for a fundamental of $(1250/1 + 2500/2 + 3850/3)/3 = 1262$ Hz.

It should be noted that the resonance frequencies are rounded to the nearest ten hertz, since the auto-correlation step size is 44 Hz, and the peak can lie anywhere within the bin. In addition, operator 'license' was used when analysing the data at base camp, in that a peak was sometimes closer to one side of the bin than the other (based on the adjacent values of the correlation), in which case the resonance frequency was 'weighted' slightly up or down within the bin. The Husky software, of course, cannot do this, but the calculated depths shown in Table 1 are deduced by the Husky, not the operator.

The double correlated values tend to be closer to the true ice depth, although the difference is not very significant, and is within the limits of the 'true' depth measurement itself. What is a 'true' depth? A single hole, drilled close to the site of acoustic investigation, is accurate only to ± 5 cm simply by the measuring process. In addition, of course, the hole may not be a true sample of the ice sheet, since it may hit a thin spot, thick spot or refrozen lead. Without carrying out extremely rigorous sampling methods, which are tiring under those conditions, it may be empirically said that the acoustic and drilled values are experimentally the same.

5. CONCLUSIONS.

The technique of using a swept acoustic source, coupled to the top surface of sea or lake ice, while monitoring the returning resonant peaks, appears to have considerable potential as a tool for measuring specific sheet thicknesses. Clearly it cannot compete with radar in terms of kilometer-lines covered, but it is much cheaper and very site specific. Recent tests in the Canadian Arctic suggest that there is little error between acoustically derived depths and hand-drilled ones.

Section 6 describes technical improvements which can only benefit the operator, and are the result of field experience. In general, the technique is still slow, because the snow must be cleared away from the ice's top surface, and the 4 devices must be bonded to the ice. If the air temperature is too warm, there may well be problems with getting the system to be repeatable. Under cold conditions, however, the technique is a most satisfying success, given the reservations expressed about it in some quarters before TDC had the courage to back the program via an Unsolicited Proposal.

6. FUTURE DEVELOPMENTS.

On the technical side, there are a number of improvements which require attention before the technology can be marketed on a wide basis.

6.1 The on-ice sensors.

At present they are the weakest link. Future designs should have a single, screened and reinforced cable from the processor to the sensors. The UW-30 acoustic source is made of tough plastic, but is still susceptible to damage in the field, given the sort of treatment any loose device gets on field trips. The accelerometers need to be more manageable; they are presently too small and fiddley to attach easily to the ice. And the method of attachment needs looking at: there must be a way of applying a steady bonding pressure between the sensors and the ice in conditions where freeze-bonding is not possible.

6.2 The electronic package.

The electronics will benefit from further miniaturization by using an STD size microprocessor, onboard operating system in ROM, and adequate RAM to store, say, 100 readings. The existing software was adequate for the field tests, but in thick ice, or very thin ice, there may be surprises which are not yet apparent.

With a built-in processor and a reduced power amplifier (even 20 watts seems excessive for 2 - 3 metres of ice), the battery capacities can be shrunk, making the system lighter (2 kg, instead of the present 4.5 kg) and therefore less susceptible to damage. (Heavy things tend to get dropped more often in the field.) The large battery shown on the left in Figure 14 could be omitted, offering savings in space as well as weight.

There is the problem of operator input. The existing system requests certain input parameters to be specified by the operator (acoustic wave velocity, top and bottom frequencies of the sweep, sample #, etc), but once the sweep has been taken and processed, there is no realistic way of knowing whether you have a 'good' set of data until the machine has finished auto-correlating. Even then, the estimate of quality is based solely on the depth calculated and its % estimate of error. If the error figure is high, there is reason to believe that the acoustic sweep was poor. But until the sweep is plotted out as an amplitude:frequency graph (back at base camp), there is no way of knowing for sure.

It would be advantageous to look at the returning amplitudes as they happen. There have recently been a number of dot matrix LCD screens coming onto the market, and these may well be necessary for subsequent field models. Some of the data presented

in Appendix III, for example, have very large spikes occurring at random intervals. Software filtering (not possible with the Husky because of operating language constraints) could get rid of most of them. Multi-pass samples of, say, 2 or 5 sweeps would also remove them. Perhaps 4 fast accumulative sweeps of 5 seconds each would be better than a single slow sweep of 20 seconds.

There are a variety of ways of improving the signal-to-noise ratio of the returning signal. In addition, there is a feeling among the authors of this report that we could accept an increased error in the depth in return for a much faster processing time if we removed the second auto-correlation completely. This would mean that final processing, using a machine level program, might well be completed in under 20 seconds, as opposed to a projected 35 seconds for a double correlation. (Present speeds are slightly over 9 minutes because of the Husky's double precision operating system, and poor math processing capability.)

The carrying case of the acoustic profiler also deserves attention. Our original thoughts were that the unit should be small enough to hang around the neck, and therefore benefit from what little body warmth is available. This may not be practical: unless the unit is pocket-sized (which it is not), the end result is a stiff neck and a tendency to leave it lying in the snow at every opportunity. A small Zero case with a top lid and carrying handle may enjoy better field use, since the electronics have proven themselves to -35°C without problems.

The inclusion of some form of 'hard copy' has been discussed at length. It is currently felt that printers are too susceptible to mechanical abuse and freezing, and would be more trouble than they are worth. All data recorded in the processor's RAM is labelled with real-time prefixes, so any record can be referenced to time during later processing. It is felt that the operator must have the responsibility of recording the ice depths, if that is deemed necessary at the time when the record is taken.

Finally, a self calibration capability would be a considerable advance. Existing set-ups require the top and bottom swept frequencies to be measured in the field, and the values entered into the Husky at the prescribed steps in the routine. These values are then used for all subsequent processing on that day. It was found that the oscillator that produced the swept frequencies was rather more temperature sensitive than expected (although still within its specified range). This meant that the unit had to be 'cold soaked' for an hour or two (usually on the way out to the site) to get the oscillator to stabilize. It would be advantageous to have an on-board frequency counter (about 3 extra chips) to do all the measuring of top and bottom frequencies automatically and to redesign the oscillator for minimum temperature fluctuations.

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APPENDIX I
Software Specifications

POLAR TECH LTD

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Document Type: PROGRAMMER'S Manual

Program: ACANAL

Written By: W. J Pann

Date: Nov. 1984

Source Contract No.: _____

Modified By: _____

Date: _____

Copy No.: ____

Purpose: To assist with the analysis of acoustice signatures for the determination of the fundamental frequency and overtones present. The analysis procedure allows for the use of FFT processing, filtering, correlation analysis and linear interpolation of original data. Printing, plotting and saving of data to disk are all incorporated.

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0.0 Introduction

This program was written to assist with the determination of fundamental frequencies in a number of acoustic signatures. These signatures were collected both under controlled (i.e. laboratory) and field conditions. The quality of data available in these signatures varied from being almost directly interpretable to being difficult to analyse by any procedure.

The initial approach taken in this work was to attempt to filter the signatures by some mechanism to sharpen peaks in the spectrum and therefore allow for a more accurate determination of the fundamental acoustic frequency. The FFT process and certain accompanying filters were applied to several of the signatures. Improvements in the determinations of fundamental frequencies were minimal.

Further investigations into the matter lead to the proposal to apply a correlation analysis technique to these acoustic signatures. At this point, with the problem of a growing complexity of information management, it was decided to write a somewhat more flexible and elaborate program to incorporate all the required facets of data processing required for this project. In addition, future developments and/or modifications would be much more readily incorporated into the work.

In order to maintain the flexibility to allow for future additions to the program and to use current structured programming techniques, the program is written as a number of discrete code blocks. Each code block logically corresponds to a single analytical function or process. New processing facilities can be added by writing and debugging them externally to the main program and then adding the virtually completed code to the current program.

1.0 Description of Algorithms

1.1 Fast Fourier Transform

The FFT algorithm was left completely intact and functional in the final ACANAL program for future potential usefulness. It is incorporated exactly as presented (Emerson, P. L., Creative Computing, July 1980) in a form specifically written for microcomputers of limited processing capabilities. The FFT can be done in both the forward and reverse directions with compensation for the change in magnitude of data values as explained in the original article. In addition to the FFT process as originally described, a number of different data filters were also incorporated into the program. These include the elimination of user selected components, the elimination of components based on a minimum amplitude criterium and the application of an exponentially rising or falling function onto the entire data set.

1.2 Correlation Analysis

Correlation Analysis as incorporated in this program involves the correlation of data with itself. That is, a given set of data points representing the variation of some parameter, such as frequency in this case, over some interval can be examined by comparing the original data with a copy of itself shifted by some arbitrary frequency offset. In the case of these acoustic signatures, the correlation coefficient should go through a maximum as the frequency by which the two signatures differ goes through a fundamental frequency or overtone present in the original data.

The basic autocorrelation expression as used as the basis for the algorithm in this program is given below.

[illegible]

This basic expression was expanded and rearranged so as to provide a series of sums which could be evaluated in a single pass through the data set. The equation used to calculate the correlation coefficients for given offsets is given below.

= sum for i=1 to (N-S)
S = size of offset for S=1 to user offset
N = number of data points

Note that both the application of FFT based filtering and the use of correlation analysis require that the data being analysed be uniformly spaced. This requirement lead to the necessity of including a simple linear interpolation algorithm into the program in order to allow the operator the option of ensuring that the data was uniformly spaced if necessary.

IMPORTANT NOTE:

Some of the code sequences and constructs in the program may seem awkward and/or unnecessary. While this may be true in some instances, beware that, especially in the incorporation of the FFT and Correlation Analysis code, significant time savings were realized for a variety of reasons (which most experienced programmers will immediately recognize) by using these "peculiar" ways of doing simple things. Modification of the code in the sections which implement the FFT and Correlation Analysis processes should be done with care. Failure to do so may cause the execution time of these processes to increase substantially.

An example of the above lies in statement 180 where several variables are set to zero. BASIC places variables in a lookup table as it encounters them in the program. Each subsequent reference to a variable causes a linear pass through the variable table in search of it. In routines which are compute bound, the amount of time spent in variable lookups can be substantial. Zeroing these variables at the beginning of the program in the order of their frequency of use (ie. most frequently used first) can dramatically (x5 or x10) decrease the execution time for processes such as FFT and Correllation Analysis.

$$R^2 = \frac{N \sum_{i=1}^{N-S} x_i (y_i + S) - \sum_{i=1}^{N-S} x_i \sum_{i=1}^{N-S} (y_i + S)}{\sqrt{[N \sum_{i=1}^{N-S} x_i^2 - (\sum_{i=1}^{N-S} x_i)^2] [N \sum_{i=1}^{N-S} (y_i + S)^2 - (\sum_{i=1}^{N-S} (y_i + S))^2]}}$$

$\sum$ = sum for i=1 to (N-S)

S = size of offset for S=1 to user offset

N = number of data points

Note that both the application of FFT based filtering and the use of correlation analysis require that the data being analysed be uniformly spaced. This requirement lead to the necessity of including a simple linear interpolation algorithm into the program in order to allow the operator the option of ensuring that the data was uniformly spaced if necessary.

IMPORTANT NOTE:

Some of the code sequences and constructs in the program may seem awkward and/or unnecessary. While this may be true in some instances, beware that, especially in the incorporation of the FFT and Correlation Analysis code, significant time savings were realized for a variety of reasons (which most experienced programmers will immediately recognize) by using these "peculiar" ways of doing simple things. Modification of the code in the sections which implement the FFT and Correlation Analysis processes should be done with care. Failure to do so may cause the execution time of these processes to increase substantially.

An example of the above lies in statement 180 where several variables are set to zero. BASIC places variables in a lookup table as it encounters them in the program. Each subsequent reference to a variable causes a linear pass through the variable table in search of it. In routines which are compute bound, the amount of time spent in variable lookups can be substantial. Zeroing these variables at the beginning of the program in the order of their frequency of use (ie. most frequently used first) can dramatically (x5 or x10) decrease the execution time for processes such as FFT and Correlation Analysis.

2.0 Program Outline

2.1 Functional Overview

This program was written to coordinate the use of a group of independent routines in such a way as to give the operator as much freedom as possible in selecting the sequence of operations to be applied to a given data set. Since a complex series of operations is possible, the main menu screen was designed to help remind the operator which operations have been completed.

To further ease the use of this program, it is designed to read any required data from the designated floppy disk file into a temporary holding array. A second series of arrays are used for carrying out all required calculations. This means that if the user makes a mistake during processing, the processing arrays can be quickly reloaded from the holding arrays rather than having to wait while the data is re-read from the floppy disk file.

Each of the following program section descriptions will indicate which key variables must be supplied to call this subroutine. The values returned will also be listed.

The subroutine which carries out the plotting function was largely copied just as written by Dr. R. Hudson. Some errors were corrected and a few minor changes were made to better suit the more structured approach to its use in this program.

The many menus which appear throughout this program are largely controlled via direct cursor addressing. While this does present a very good mechanism for controlling the screen layout, it was incorporated in a manner which is somewhat dependent on the number of data description fields to be placed on the screen. This means that if a new field is to be added to a particular screen, the number of data fields read and their placement on the screen must be corrected. This correction will have a cascading effect throughout all of the remaining screens in the linear sequence of the source code. This phenomena results from the use of specific numbers rather than the use of relative variables for reading data statements and locating text on the screen. Pressures of time and money prevented the cleanup and generalization of this aspect of the program.

The section of code from 5590 to 5600 is excluded from activation in the current program. It was created to provide a list of data elements which have been rejected through the use of filter types 1 or 2. The rejected components are marked and stored in the array REJ(). This code was not tested and implemented due to a lack of time on the contract and the fact that the necessary results were obtainable without its use. This function should be completed at some later date when time permits.

2.2 Variable Dictionary

The variables listed in the following dictionary are only those of a global nature. Loop counters and other such temporary variables are not included. The main intent of this variable dictionary is to describe those variables having relevance to more than one module in the program. This should facilitate the addition of any new modules.

- A(256) - A special processing array holding a copy of all the "Y" values to be used just for the real part of the FFT processing.
- B(256) - A special processing array to be used to represent the complex number coefficients of the FFT.
- DATA.MASK\$ - A character string which is used as a print statement formatting mask for outputting data values to the printer.
- DES.MASK\$ - A character string which is used as a print statement formatting mask for outputting the data description parameters.
- DROP.MASK\$ - A character string which is used as a print statement formatting mask for printing out a list of rejected frequency components.
- FFT.DIR - A variable controlling the direction which the FFT process will take. The default direction as established in main program is 1 --> Forward. When a reverse or backward transform has been selected, the value is set to 2.
- FFT.DIR\$ - A string containing either the word "Forward" or "Backward" for display to the user. The loading of this message is clearly dependent on the value of the variable FFT.DIR.
- FFT.DONE - Flag indicating whether an FFT procedure has been performed. It is reset to 0 whenever a file is read.
- FI\$ - User supplied data file name.
- FILTER - Four different types of data filters can be used as selected by the operator. This variable encodes the type of filter chosen as follows: 1 --> Rejection of selected components, 2 --> Rejection on minimum amplitude of a frequency component, 3 --> Application of a user selected exponential window function, 4 --> none.
- FILTER.TYPE\$ - A string description containing the text in the

prompt requesting the user to indicate the desired filter type. The first 5 characters containing the selection number and spacing in the prompt are dropped in order that just the descriptive text remains.

FILTER.VAL - This variable represents the actual value of the selected filter. In the case of (2) above, FILTER.VAL represents the minimum amplitude to be used for rejecting components. In the case of (3) above, FILTER.VAL represents a factor F in the exponential window function $1/\text{EXP}(i \cdot F/N)$, where N is the total number of data values in the set.

LOAD.MODE - A 1 indicates that the arrays were loaded T1 --> XP and T2 --> YP while a 2 indicates that they were loaded T1 --> YP and T2 --> XP. It is reset to 0 whenever a file is read.

MIN.AMP - The minimum amplitude threshold below which individual frequency components will not be included in a data listing.

MS\$(50) - Array containing all of the screen display (ie for menus) text and therefore the text required for the menus in this routine.

NUM.OF.PTS - The number of points actually contained in the XP and YP arrays. This value must be updated in case the user is reloading the arrays without having read in a new file.

NUM - The number of points to be generated during the process of creating a linearly interpolated data set from an original unevenly spaced set.

OLD.FFT.DIR - The previous value selected for FFT.DIR

OLD.FILTER - The previous value selected for FILTER

OLD.FILTER.VAL - The previous value selected for FILTER.VAL

OLD.MIN.AMP - The previous value selected for MIN.AMP

OLD.NUM - The previous value selected for NUM

OLD.STEP. - The previous value selected for STEP.

ORIG.PTS - The number of data points or records found in the data file and loaded into the holding array.

OUT.MASK\$ - A character string which is used as a print statement formatting mask for printing out a list of rejected frequency components.

STEP. - The size of the steps used in the correlation analysis

in terms of the X axis units. In the case of acoustic analysis this means Hz. For example, the selection of 5000 hz would mean that the original data would be correlated in steps starting with Xrange/NUM and ending with the largest whole multiple of it which is still less than 5000.

T1(256) - Temporary holding array for one variable.

T2(256) - Temporary holding array for a second variable.

T1.MAX - The maximum value found for the first element in each of the records read in for the newly loaded data set.

T1.MIN - The minimum value found for the first element in each of the records read in for the newly loaded data set.

T2.MAX - The maximum value found for the second element in each of the records read in for the newly loaded data set.

T2.MIN - The minimum value found for the second element in each of the records read in for the newly loaded data set.

TD1 - The maximum value calculated for the first variable to be convenient as a limit for plotting of the data.

TD2 - The maximum value calculated for the second variable to be convenient as a limit for plotting of the data.

2.3 Description of Program Units

X(5) - An array loaded with a description of the XP() data as given below:

- X(1) - lowest value in the set.
- X(2) - highest value in the set.
- X(3) - lowest rounded range limit for plotting.
- X(4) - highest rounded range limit for plotting.
- X(5) - $X(4) - X(3) / 5$ to be used for a plot tick mark segment length to give 5 axis segments.

X.LABEL\$ - The alphanumeric label for labeling the X axis of a plot.

XP(256) - The "X" processing array loaded with original data in the user designated manner.

Y(5) - An array loaded with a description of the YP() data as given below:

- Y(1) - lowest value in the set.
- Y(2) - highest value in the set.
- Y(3) - lowest rounded range limit for plotting.
- Y(4) - highest rounded range limit for plotting.

$Y(5) - Y(4) - Y(3)/5$ to be used for a plot tick mark
segment length to give 5 axis segments.

Y.LABEL\$ - The alphanumeric label for labeling the Y axis of a
plot.

YP(256) - The "Y" processing array loaded with original data in
the user designated manner.

2.3.1 Main Control Section

The main program dimensions all arrays, initializes variables, defines functions, defines constants and reads in the contents of all the DATA statements. Once all of the administrative details have been completed, the main menu is displayed and further program control is passed to the appropriate subroutines. Once these routines are completed the main menu is redisplayed with the appropriate information updated.

Note that the program lines from 900-998 contain only the DATA statements applicable to this section of the program. Although this main routine reads in ALL of the DATA statement contents, the individual DATA statements are to be found in the final part of whatever subroutine they are related to. This was done for clarity and ease of debugging during program development and also makes the inclusion of selected subroutines into other programs much easier.

Direct curser addressing was used in order to control the screen displays. This was achieved by defining a special function as follows to place the cursor where desired on the screen.

```
DEF FNS$(X,Y) = CHR$(30)+STRING$(Y,10)+STRING$(X,12)
```

where character #30 moves the cursor to Home (ie the
upper left hand corner of the screen
#10 moves the cursor right one character
#12 moves the cursor down one line

An additional feature used was that of clearing the screen which was done through defining CLS\$ as character #26 which clears the screen on a KAYPRO II.

```
10 REM
160 DEFINT T,R
170 DIM A(256),B(256),AM(256),P(50)
180 I=0: J=0: SXY=0: SX=0: SY=0: SX2=0: SY2=0: X.INC=0:
STEP.=0: T=0: R=0: S=0: M=0: K=0: X1=0: X2=0: Y1=0: Y2=0: Z=0:
Z1=0: Z2=0: ND2=0: ND4=0: N=0: U=0: V=0: IS=0: D=0
190 DIM T1(256),T2(256),XP(256),YP(256),MS$(50),FFT.DIR$(2),
REJ(256), FLAG$(1)
200 SELECT$="Select Required Action Via Corresponding Number ":
LOAD.MODE=-1: FI$="None Selected": B79$=STRING$(79,32): LIN=16:
B25$=STRING$(25,32)
210 X.LABEL$="X - Axis": Y.LABEL$="Y - Axis": FILTER.TYPE$="No
Filter Selected": FFT.DIR$(0)=" ":
FFT.DIR$(1)="Forward": FFT.DIR$(2)="Backward": FLAG$(0)=" ":
```



```

FLAG$(1)="**"
212 X(6)=1: Y(6)=1
220 DEF FNS$(X,Y)=CHR$(30)+STRING$(Y,10)+STRING$(X,12)
230 FFT.DIR=1: STEP.=1000: NUM=64
240 PRINT.FLAG=0: DATA.MASK$="####          #####.###          #####.###
#####   ###.####   #####.####": CLS$=CHR$(26)
250 OUT.MASK$=STRING$(10,32)+"#### \ \ #####.###          #####.####
#####.####": DROP.MASK$=STRING$(32,32)+"####   ##.###   ##.####
##.####"
260 DES.MASK$="\ \#####.####   #####.####   #####.####   #####.####
#####.#### \
\ "
270 FOR I=1 TO 43: READ MS$(I): NEXT
280 PRINT CLS$;TAB(20);"Acoustic Signature Analysis - V1.0": PRINT
TAB(20);STRING$(34,"-"): PRINT: PRINT
290 FOR I=1 TO 6: LINE.=2+2*I: PRINT
FNS$(0,LINE.);MS$(I);FNS$(40,LINE.);MS$(I+6): NEXT
300 PRINT FNS$(0,18);STRING$(78,"-")
310 PRINT "Data File: ";FI$;TAB(30);"FFT Direction:
";FFT.DIR$(FFT.DIR);"   Corr'n Step (hz): ";STEP.: PRINT
320 PRINT "Filter: ";FILTER.TYPE$;TAB(40);"Factor: ";FILTER.VAL;"
Num. Pts.: ";NUM.OF.PTS;"   N: ";N: PRINT FNS$(0,23);"Linear
Interpolation Pts.: ";NUM;
321 PRINT FNS$(0,0)
330 PRINT FNS$(5,16);SELECT$;; PRINT FNS$(55,16);: INPUT ACT
340 IF ACT<0 OR ACT>11 THEN 280
350 IF ACT=11 THEN END
360 ON ACT+1 GOSUB
1000,2000,3000,4000,5000,6000,11000,12000,7000,16000,17000
370 GOTO 280
800 FOR I=LINE. TO 22: PRINT FNS$(0,I);STRING$(79,32): NEXT:
RETURN
900 DATA "0) Read Data File","1) Load Data for Processing",
"2) Access Data Description Parameters"
902 DATA "3) Access Processing Parameters","4) Print/Display
Parameters/Data",
"5) Apply Selected Filter","6) Apply Fourier Transform"
904 DATA "7) Plot Current Data List","8) Save Current Data List To
Disk","9) Generate Interpolated Data"
906 DATA "10) Perform Correlation Analysis","11) Exit"

```

2.3.2 Reading in a Data File

Variables to be Provided:

T1(256), T2(256)

Variables Returned:

FFT.DONE, FI\$, LOAD.MODE, ORIG.PTS, T1.MAX, T1.MIN, T2.MAX,
T2.MIN, TD1, TD2

This subroutine reads either the first two elements or numbers found in each multi-element record or the single value in a single element record of the data file provided. In the latter case (i.e. the use of a single column data file), the second value is calculated by taking the X data maximum, subtracting the X data minimum and dividing the result by the number of data points read in from the file. The missing X values are calculated as $i \times X_{inc}$, where the X_{inc} (rement) is calculated as indicated in the previous sentence. These values are stored in the two corresponding holding or temporary storage arrays, one for each set of numbers. Once the data has been read in, the maximum value in each set is found. The last operation determines a proposed value to be used as a maximum for plotting of the data for both sets of numbers.

Before returning to the calling routine certain flags used elsewhere in the program are reset to indicate that a fresh start is being taken. This essentially allows the program to behave as if it was being restarted.

```
999 REM Read Data File*****
1000 PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);: INPUT"Enter Data File
Name:";FI$
1002 CO=2: PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);: INPUT"No of
Columns in Data File:";CO: IF CO<=0 THEN CO=2
1010 OPEN"I",#1,FI$ : I=1: FFT.DONE=0
1020 IF EOF(1) THEN CLOSE 1: LOAD.MODE=0: NUM.OF.PTS=I-1:
ORIG.PTS=NUM.OF.PTS: GOTO 1080
1030 IF I=2 THEN T1.MIN=T1(1): T1.MAX=T1(1): T2.MIN=T2(1):
T2.MAX=T2(1)
1040 IF CO>=2 THEN INPUT#1,T1(I),T2(I) ELSE INPUT#1,T1(I)
1050 IF T1(I)<T1.MIN THEN T1.MIN=T1(I) ELSE IF T1(I)>T1.MAX THEN
T1.MAX=T1(I)
1060 IF CO>=2 THEN IF T2(I)<T2.MIN THEN T2.MIN=T2(I) ELSE IF
```

```
T2(I)>T2.MAX THEN T2.MAX=T2(I)
1070 I=I+1: GOTO 1020
1080 VALUE=T1.MAX: GOSUB 1900: TD1=TOP.VAL
1082 IF CD=1 THEN T=(X(2)-X(1))/(NUM.OF.PTS-1): FOR I=0 TO
NUM.OF.PTS-1: T2(I)=X(1)+T*I: NEXT: T2.MIN=T2(1):
T2.MAX=T2(NUM.OF.PTS)
1090 VALUE=T2.MAX: GOSUB 1900: TD2=TOP.VAL
1100 RETURN
1900 M=.00001: L=0: SIGN=1: IF VALUE<0 THEN SIGN=-1
1905 VALUE=ABS(VALUE)
1910 L=L+1: M=10*M: IF M<VALUE THEN 1910
1920 M.M=1: L.L=0: M=M/10 : IF M>=1 THEN M=INT(M)
1930 L.L=L.L+1: M.M=L.L*M: IF M.M<VALUE THEN 1930
1940 TOP.VAL=SIGN*M.M: RETURN
```

2.3.3 Loading the Processing Array

Variables to be Provided:

A(256), LOAD.MODE, MS\$(50), ORIG.PTS, T1(256), T2(256), X(5),
XP(256), Y(5), YP(256)

Variables Returned:

A(256), LOAD.MODE, NUM.OF.PTS, X(5), XP(256), Y(5), YP(256)

This subroutine allows the user to transfer the data from the holding arrays to the processing arrays. It provides the flexibility to load the array corresponding to either the first or second field in the original file records as the XP and/or YP values. Each time the processing array is reloaded, all of the appropriate flags are reset in order that the main menu status displays are correct.

The part of this subroutine from 2800-2890 is a general purpose section of code used to find the extremes in a data set as well as to generate reasonable limits for plotting the data. Since other subroutines in this program significantly alter the values in the data arrays, the resetting of these limits was found to be necessary in several other locations. Such further use of this code is documented wherever it occurs. Should it become necessary to modify this code it is recommended to first assess the ramifications of the proposed modifications on the rest of the program.

```
1999 REM Load Data for Processing *****
2000 PRINT CLS$;FNS$(20,0);"Load Data for Processing";FNS$(20,1);
STRING$(24,"-"): PRINT: PRINT
2010 FOR I=13 TO 15: LINE.=3+(I-13)*2: PRINT FNS$(10,LINE.);MS$(I)
: NEXT
2012 PRINT FNS$(0,14);STRING$(78,"-"): PRINT
2015 IF LOAD.MODE<=0 THEN PRINT FNS$(15,16);"No Data File Loaded
Yet": PRINT
2020 IF LOAD.MODE=1 THEN PRINT FNS$(15,16);"Field 1 { H() }
---->> Processsing Array { A() }": PRINT
2030 IF LOAD.MODE=2 THEN PRINT FNS$(15,16);"Field 2 { V() }
---->> Processing Array { A() }": PRINT
2035 PRINT STRING$(78,"-")
2040 PRINT FNS$(5,10);SELECT$;; INPUT ACT
2050 IF ACT<1 OR ACT>3 THEN 2000
2055 IF ACT=3 THEN RETURN
```

```

2060 LOAD.MODE=ACT: FFT.DONE=0: NUM.OF.PTS=ORIG.PTS
2090 PRINT FNS$(0,16);B79$;FNS$(15,16);"Loading....":
NUM.OF.PTS=ORIG.PTS: ON LOAD.MODE GOTO 2100,2200
2100 FOR I=1 TO ORIG.PTS: YP(I)=T1(I): A(I)=T1(I): XP(I)=T2(I):
NEXT: GOSUB 2800: GOTO 2015
2200 FOR I=1 TO ORIG.PTS: YP(I)=T2(I): A(I)=T2(I): XP(I)=T1(I):
NEXT: GOSUB 2800: GOTO 2015
2230 DATA "1 - Load Array H (first field in file record) for
Processing",
"2 - Load Array V (second field in file record) for Processing"
2240 DATA "3 - Return to Main Menu"
2800 T1.MIN=YP(1): T1.MAX=YP(1): T2.MIN=XP(1): T2.MAX=XP(1)
2810 FOR I=1 TO NUM.OF.PTS
2820 IF YP(I)<T1.MIN THEN T1.MIN=YP(I) ELSE IF YP(I)>T1.MAX THEN
T1.MAX=YP(I)
2830 IF XP(I)<T2.MIN THEN T2.MIN=XP(I) ELSE IF XP(I)>T2.MAX THEN
T2.MAX=XP(I)
2840 NEXT
2850 VALUE=T1.MAX: GOSUB 1900: TD1=TOP.VAL: VALUE=T1.MIN: GOSUB
1900: TL1=TOP.VAL-TOP.VAL/10
2860 VALUE=T2.MAX: GOSUB 1900: TD2=TOP.VAL: VALUE=T2.MIN: GOSUB
1900: TL2=TOP.VAL-TOP.VAL/10
2870 Y(1)=T1.MIN: Y(2)=T1.MAX: Y(3)=TL1: Y(4)=TD1:
Y(5)=(TD1-TL1)/5
2880 X(1)=T2.MIN: X(2)=T2.MAX: X(3)=TL2: X(4)=TD2:
X(5)=(TD2-TL2)/5
2890 RETURN

```


2.3.4 Accessing the Data Description Parameters

Variables to be Provided and Returned:

MS\$(50), X(5), X.LABEL\$, Y(5), Y.LABEL\$

This subroutine takes the values provided for the X and Y array data description parameters as provided in the two arrays X() and Y() and displays them on the screen along with a legend indicating the meaning of each. An additional menu is also made available for allowing the user to selectively change any value. The values provided by this routine are those used for all further output or plotting control. This routine provides the user with a mechanism for overriding any program provided default values.

```
2999 REM Access Data Description Parameters *****
3000 PRINT CLS$;FNS$(20,0);"Display/Edit Data Description
Parameters";FNS$(20,1);STRING$(40,"-");: COL=0
3010 FOR I=16 TO 22: LINE.=2+(I-16)*2: PRINT
FNS$(10,LINE.);MS$(I);FNS$(40,LINE.);MS$(I+7);: NEXT: PRINT
FNS$(60,2);"15 - Return to";FNS$(65,3);"Main Menu";
3020 PRINT FNS$(COL+23,18);"Axis   Axis   Axis   Plot": PRINT
FNS$(COL+7,19);"Min     Max     Min     Max     Seg     Scale
Label": PRINT FNS$(COL,21);"X";FNS$(COL,22);"Y";
3030 GOSUB 3700
3040 PRINT FNS$(10,16);SELECT$;: INPUT ANS: IF ANS<1 OR ANS >15
THEN 3040 ELSE IF ANS=15 THEN RETURN
3100 IF ANS>7 THEN 3200 ELSE M$=MS$(15+ANS): GOSUB 3800: IF ANS=7
THEN X.LABEL$=VALUE$: GOTO 3240
3110 ON ANS GOTO 3120,3120,3130,3130,3120,3120
3120 X(ANS)=VALUE: GOTO 3240
3130 X(ANS)=VALUE: X(5)=(X(4)-X(3))/5: GOTO 3240
3200 M$=MS$(15+ANS): ANS=ANS-7: GOSUB 3800: IF ANS = 7 THEN
Y.LABEL$=VALUE$
3210 ON ANS GOTO 3220,3220,3230,3230,3220
3220 Y(ANS)=VALUE: GOTO 3240
3230 Y(ANS)=VALUE: Y(5)=(Y(4)-Y(3))/5: GOTO 3240
3240 GOSUB 3700: GOTO 3040
3700 PRINT FNS$(COL+1,21);STRING$(78,32);FNS$(COL+1,22);
STRING$(78,32);
3710 FOR I=1 TO 6: POS.=COL+I*8-2: PRINT FNS$(POS.,21);X(I);
FNS$(POS.,22);Y(I);: NEXT: POS.=COL+55
3720 PRINT FNS$(POS.,21);X.LABEL$;FNS$(POS.,22);Y.LABEL$;: RETURN
3800 PRINT FNS$(10,16);STRING$(60,32);FNS$(10,16);"Enter New
";MID$(M$,4);: INPUT VALUE$: IF ANS<>7 THEN VALUE=VAL(VALUE$)
3810 RETURN
3900 DATA "1 - Minimum X","2 - Maximum X","3 - X-Axis Minimum","4
- X-Axis Maximum","5 - X-Axis Segment Size","6 - X Plot Scale
Factor","7 - X-Axis Label"
3910 DATA "8 - Minimum Y","9 - Maximum Y","10 - Y-Axis
```

Minimum", "11 - Y-Axis Maximum", "12 - Y-Axis Segment Size", "13 - Y
Plot Scale Factor", "14 - Y-Axis Label"

2.3.5 Access Processing Parameters

Variables to be Provided and Returned:

A(256), B(256), FFT.DIR, FFT.DIR\$, FILTER, FILTER.TYPE\$,
FILTER.VAL, MIN.AMP, MS\$(50), NUM, OLD.FFT.DIR, OLD.FILTER,
OLD.FILTER.VAL, OLD.MIN.AMP, OLD.NUM, OLD.STEP., STEP.

This routine is supplied with a starting value for each of the processing control parameters as described above. These values are listed as the current values while the previous ones are given as 0. Each time one of these parameters is changed by the user, the current value is stored as the old value and only then is the current value updated with the most recent change. Both the old and current values of all the variables are then refreshed on the screen.

```
3999 REM Access Processing Parameters *****
4000 PRINT CLS$;FNS$(20,0);"Display/Edit Processing Parameters";
FNS$(20,1);STRING$(34,"-"): COL=10: BLIN=18
4010 FOR I=30 TO 36: LINE.=4+(I-30)*2: PRINT FNS$(5,LINE.);MS$(I):
NEXT
4020 PRINT FNS$(50,3);"PREVIOUS      CURRENT": GOSUB 4800
4030 PRINT FNS$(0,BLIN);STRING$(79,32);FNS$(10,BLIN);SELECT$;;
INPUT ANS: IF ANS<1 OR ANS>7 THEN 4030 ELSE IF ANS=7 THEN RETURN
4040 ON ANS GOSUB 4060,4100,4200,4500,4550,4580: LINE.=BLIN: GOSUB
800: GOTO 4020
4060 LINE.=BLIN: PROMPT$=MID$(MS$(30),5): GOSUB 4700: IF A$=""
THEN RETURN ELSE OLD.MIN.AMP=MIN.AMP: MIN.AMP=VAL(A$): RETURN
4100 PRINT FNS$(0,BLIN-1);STRING$(79,"-"): LINE.=BLIN+0: FOR I=0
TO 1: POS.=LINE.+2*I: PRINT
FNS$(0,POS.);MS$(37+I);TAB(40);MS$(39+I): NEXT
4110 PRINT FNS$(5,LINE.+4);"Select Number Corresponding to Desired
Filter Type": INPUT ANS: IF ANS<1 OR ANS>4 THEN 4110 ELSE
OLD.FILTER=FILTER: FILTER=ANS
4120 FILTER.TYPE$=MID$(MS$(36+ANS),5): PRINT FNS$(0,BLIN-1);B79$:
RETURN
4200 IF FILTER=0 THEN PRINT FNS$(10,LINE.);"Select a Filter Type
First! (type <RETURN> to Continue)": INPUT A: RETURN
4210 ON FILTER GOSUB 4220,4300,4400: RETURN
4220 LINE.=BLIN: PROMPT$="Component No. to be Deleted ": GOSUB
4700: IF A$="" THEN RETURN ELSE V=VAL(A$): A(V)=0: B(V)=0:
REJ(V)=1: GOTO 4220
4300 LINE.=BLIN: PROMPT$="Enter Min. Amp. Rejection Threshold ":
GOSUB 4700: IF A$="" THEN RETURN ELSE OLD.FILTER.VAL=FILTER.VAL:
FILTER.VAL=VAL(A$): RETURN
4400 LINE.=BLIN: PROMPT$="Enter Exponential Factor F in ( 1 /
EXP(i*F/N) ) ": GOSUB 4700: IF A$="" THEN RETURN ELSE
OLD.FILTER.VAL=FILTER.VAL: FILTER.VAL=VAL(A$): RETURN
4500 LINE.=BLIN: PROMPT$="(F)orward or (B)ackward: ": GOSUB 4700:
```

```

IF A$="" THEN RETURN
4510 OLD.FFT.DIR=FFT.DIR: IF A$="F" THEN FFT.DIR=1:
FFT.DIR$="Forward" ELSE FFT.DIR=2: FFT.DIR$="Backward"
4520 RETURN
4550 LINE.=BLIN: PROMPT$="Correlation Analysis Step Size in Hz.:
": GOSUB 4700: IF A$="" THEN RETURN
4560 OLD.STEP=STEP.: STEP.=VAL(A$): RETURN
4580 LINE.=BLIN: PROMPT$="No. of Points in Linear Interpolation:
": GOSUB 4700: IF A$="" THEN RETURN
4590 OLD.NUM=NUM: NUM=VAL(A$): RETURN
4700 GOSUB 800: PRINT FNS$(10,LINE.);PROMPT$;: A$="": INPUT A$:
RETURN
4800 COL=62: LINE.=4: PRINT FNS$(50,LINE.);B25$;FNS$(50,LINE.);
OLD.MIN.AMP;FNS$(COL,LINE.);MIN.AMP
4810 PRINT FNS$(50,LINE.+2);B25$;FNS$(50,LINE.+2);OLD.FILTER;
FNS$(COL,LINE.+2);FILTER
4820 PRINT FNS$(50,LINE.+4);STRING$(25,32);FNS$(50,LINE.+4);
OLD.FILTER.VAL;FNS$(COL,LINE.+4);FILTER.VAL
4830 PRINT FNS$(50,LINE.+6);B25$;FNS$(51,LINE.+6);
LEFT$(FFT.DIR$(OLD.FFT.DIR),1);FNS$(COL+1,LINE.+6);
LEFT$(FFT.DIR$(FFT.DIR),1)
4840 PRINT FNS$(50,LINE.+8);B25$;FNS$(50,LINE.+8);OLD.STEP;
FNS$(COL,LINE.+8);STEP.
4845 PRINT FNS$(50,LINE.+10);B25$;FNS$(50,LINE.+10);OLD.NUM;
FNS$(COL,LINE.+10);NUM
4850 PRINT FNS$(35,BLIN-2);STRING$(44,32);FNS$(35,BLIN-2);"<
";FILTER.TYPE$;">"
4860 RETURN
4900 DATA "1 - Minimum Amplitude for Data List","2 - Select Filter
Type","3 - Set Filter Parameter(s)","4 - FFT Direction"
4902 DATA "5 - Correlation Analysis Differential (hz)","6 - Number
of Points in Linear Interpolation","7 - Return to Main Menu"
4910 DATA "1 - Selected Component(s) Rejection","2 - Minimum
Amplitude Rejection","3 - Exponential Window Function","4 - No
Filtering"

```


2.3.6 Print/Display Parameters/Data

Parameters to be Supplied :

DATA.MASK\$, DES.MASK\$, FILTER, FILTER.VAL, FILTER.TYPE\$, MIN.AMP,
MS\$(50), NUM, NUM.OF.PTS, ORIG.PTS, OUT.MASK\$, STEP., X(6),
X.LABEL\$, XP(256), Y(6), Y.LABEL\$, YP(256)

This module allows the user to display the raw data as read in from the data file as well as in whatever processed form the user has selected. This includes evenly spaced data coming out of the linear interpolation routine, FFT results and of course results of the correlation analysis if performed. All of the data displayed can also be printed out on an attached printer. When printed out, all of the data description parameters are included.

```
4999 REM Print/Display Parameters/Data *****
5000 PRINT CLS$;FNS$(20,0);"Print/Display Parameters and Data";
FNS$(20,1);STRING$(33,"-")
5010 FOR I=41 TO 43: LINE.=3+(I-41)*2: PRINT FNS$(23,LINE.);
MS$(I): NEXT
5020 PRINT FNS$(10,LINE.+2);SELECT$;; INPUT ANS: IF ANS<1 OR ANS>3
THEN 5020 ELSE IF ANS=3 THEN RETURN
5030 ON ANS GOSUB 5100,5500: GOTO 5000
5100 PRINT CLS$;FNS$(0,0);"Component      Amplitude      Frequency
Period      Array A      Array B": PRINT FNS$(0,1);STRING$(62,"-");
HOLD=0
5105 NUM.OUT=ORIG.PTS: IF FFT.DONE>0 THEN NUM.OUT=NUM.OF.PTS
5110 FOR I=1 TO NUM.OF.PTS: L=((I-1) MOD 20)+2
5120 PRINT FNS$(0,L);B/9$;FNS$(0,L);: PRINT USING DATA.MASK$;
I,AM(I),XP(I),YP(I),A(I),B(I): PRINT FNS$(0,L+1);B/9$
5130 IF L=21 THEN HOLD=1
5140 IF HOLD=1 THEN PRINT FNS$(70,L);: A$=INPUT$(1): IF
A$=CHR$(13) THEN HOLD=0 ELSE IF ASC(A$)=27 THEN RETURN
5150 NEXT: A$=INPUT$(1): RETURN
5500 EP$=CHR$(27)+"G": EP.OFF$=CHR$(27)+"H": DC$=CHR$(14): PRINT
FNS$(5,9);"Ensure That the EPSON or Equivalent Printer is Properly
Attached": PRINT FNS$(20,11);"Type <any key> to Continue": :
A$=INPUT$(1)
5510 HH$=CHR$(27)+"<": LPRINT DC$;"      Acoustic Signature
Analysis": LPRINT: LPRINT TAB(20);"Source Data File: "; EP$;FI$;
EP.OFF$: LPRINT
5515 LPRINT EP$;TAB(20);"Data Description Parameters": LPRINT
TAB(18);STRING$(27,"-");EP.OFF$: LPRINT
5520 LPRINT TAB(29);"Axis      Axis      Axis": LPRINT
TAB(7);"Min      Max      Min      Max      Seg
Label": LPRINT TAB(3);"-----"
5530 LPRINT USING DES.MASK$;"X",X(1),X(2),X(3),X(4),X(5),X.LABEL$
5540 LPRINT USING DES.MASK$;"Y",Y(1),Y(2),Y(3),Y(4),Y(5),Y.LABEL$
```



```

5550 LPRINT: LPRINT EP$;TAB(20);"Data Processing Parameters":
LPRINT TAB(18);STRING$(26,"-"): LPRINT EP.OFF$
5560 LPRINT TAB(10);"Minimum Amplitude for Data Listing: ";
MIN.AMP: LPRINT
5570 LPRINT TAB(10);"Filter Type: ";FILTER.TYPE$;: IF FILTER<>1
AND FILTER<>4 THEN LPRINT TAB(55);"Filter Value: ";FILTER.VAL:
LPRINT
5572 LPRINT TAB(10);"Correlation Analysis Step (Hz): ";STEP.:
LPRINT
5574 LPRINT TAB(10);"Number of Original Data Points: ";ORIG.PTS:
LPRINT
5576 LPRINT TAB(10);"Number of Linearly Interpolated Points:
";NUM: LPRINT
5580 IF FILTER <>1 OR FILTER <>2 THEN 5700
5585 GOTO 5700
5590 LPRINT "The Following Components were Rejected:      Component
No.  Amplitude": LPRINT TAB(42);STRING$(24,"-")
5600 FOR I=1 TO REJ(0): LPRINT USING DROP.MASK$;REJ(I),AM(REJ(I)):
NEXT: LPRINT: LPRINT
5700 LPRINT: LPRINT EP$;TAB(20);"List of Current Data": LPRINT
TAB(18);STRING$(20,"-");EP.OFF$: LPRINT
5730 LPRINT TAB(11);"Element    Amplitude    Frequency    Period
(x1000)": LPRINT TAB(10);STRING$(57,"-"): COUNT=1
5734 FOR I=1 TO NUM.OF.PTS: FLAG$=" ": IF REJ(COUNT)=I THEN
FLAG$="***": COUNT=COUNT+1
5740 LPRINT USING OUT.MASK$;I,FLAG$,YP(I),XP(I),1000/XP(I)
5744 NEXT
5760 LPRINT CHR$(12): RETURN
5900 DATA "1 - Display Current Data","2 - Print
Parameters/Data","3 - Return to Main Menu"

```

2.3.7 Apply a Selected Filter

Parameters to be Supplied:

A(256), AM(256), B(256), FFT.DONE, FILTER.VAL, NUM.OF.PTS,
REJ(256)

Parameters to be Returned:

A(256), AM(256), B(256), REJ(256)

The capability of applying a filter, that is modifying the data at some point in the processing cycle, was originated for use with the FFT routine. It is standard practice to perform an FFT in one direction, filter or alter the intermediate results in some fashion and then perform the inverse FFT function. In order to truly generalize the use of data filters, they have been incorporated in a completely fashion so that they can be applied under any circumstances. The application of a filter to FFT intermediate results must be done differently than an application of the same filter to non-FFT data. This difference is detected by the routine and the operator need not be concerned about the adjustment.

In the case of FFT intermediate data, the fact that N data points give rise to only N/2 frequency components and that components N-i and i+1 must be treated identically as a pair must be recognised. This is true of all three filter types.

Normal data is simply treated as a linear sequence of N values again for all three filter types.

This routine includes the ability to perform three different types of filters; Selected Components, Minimum Amplitude and Exponential Window. The Selected Components filter allows the user to select individual elements of the working data array and zero them. Any number of components can be selected in any order. A record is kept of the deleted components in the array REJ(256). These are listed with a star or asterisk beside them in any printout produced.

The minimum amplitude filter allows the user to specify a minimum value for the amplitude of an FFT single frequency component. Any frequencies having an amplitude greater than or equal to that specified are retained while all others are set to zero. The amplitude of a particular frequency component is calculated as

$$AM(i) = \sqrt{\frac{A(i+1) + A(n-i+1) \cdot 2 + (B(i+1) + B(n-i+1) \cdot 2}{N}}$$

where N == the number of values in the data set
 A() == the real number coefficients of the FFT
 B() == the imaginary coefficients of the FFT
 i == the i th component

The exponential filter, rather than eliminating selected data values, is used to modify all of the data values in a coherent, user determined fashion. The form of the exponential function is

$$e^{i * (-F) / N}$$

where i == the i th data element in the array
 F == the user supplied factor determining the "steepness" of the function.
 N == the number of data values in the processing array or in the FFT array.

In the case of normal data, this function is applied for N = 1 through NUM.OF.PTS. The exponential filtering of FFT data is more complex. It requires the filter to be applied equally to value pairs in both the real (A()) and imaginary (B()) arrays. The data pairs referred to are the (i+1) & (N-i+1) elements of the A and B arrays. The differences in the application of this filter are transparent to the user but must be dealt with properly in these routines or any others which are added.

```
5999 REM Apply Selected Filter*****
6000 PRINT FNS$(0,LIN);B79$;FNS$(5,15);"Working...."
6010 ON FILTER GOSUB 6100,6200,6300: RETURN
6100 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Enter Component Number
to be Set to ZERO ( 0 to QUIT) :"; I=0: INPUT I: IF I<0 OR
I>NUM.OF.PTS THEN PRINT"INVALID COMPONENT NUMBER ***": GOTO 6100
6110 IF I=0 THEN RETURN
6120 IF FFT.DONE=1 THEN GOSUB 6700 ELSE GOSUB 6800
6130 GOTO 6100
6200 REM THIS SUBROUTINE FILTERS BY AMPLITUDE MINIMUM REJECTION
6220 FOR I=1 TO NUM.OF.PTS
6230 IF AM(I)<FILTER.VAL THEN IF FFT.DONE=1 THEN GOSUB 6700 ELSE
GOSUB 6800
6240 NEXT
```

```
6250 RETURN
6300 REM This subroutine filters by reducing transformed values
using an
6310 REM exponential function controlled by the user
6340 IF FILTER.VAL<0 THEN GOTO 6400
6350 REM F=FILTER.VAL: FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1:
T=EXP(I*(-F)/NUM.OF.PTS): A(I1)=T*A(I1): A(I2)=T*A(I2):
B(I1)=T*B(I1): B(I2)=T*B(I2): NEXT: RETURN
6352 F=FILTER.VAL: FOR I=1 TO NUM.OF.PTS: T=EXP(I*(-F)/NUM.OF.PTS)
:A(I)=T*A(I): B(I)=T*B(I): YP(I)=T*YP(I): NEXT: RETURN
6360 RETURN
6400 F=ABS(FILTER.VAL): FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1:
T=EXP((I2)*(-F)/NUM.OF.PTS): A(I1)=T*A(I1): A(I2)=T*A(I2):
B(I1)=T*B(I1): B(I2)=T*B(I2): NEXT: RETURN
6700 I1=I+1: I2=N-I+1: A(I1)=0: B(I1)=0: A(I2)=0: B(I2)=0:
REJ(I1)=1: REJ(I2)=1: RETURN
6800 A(I)=0: B(I)=0: REJ(I)=1: RETURN
```

2.3.8 Save the Current Data List to Disk

Parameters to be Supplied:

FFT.DONE, NUM.OF.PTS, NUM.OUT, ORIG.PTS, XP(256), YP(256)

Parameter to be Returned:

FI\$

This routine prompts the user for an output file name and proceeds to store the XP() and YP() data arrays onto disk. These arrays contain the values which are used by the plotting routine to produce any user selected plots. No selection capability has been included in this routine since for the original application the storage of data in its graphically significant form was the only meaningful option.

Notice that in the case of FFT processing having been done, the number final data points for plotting or storing to disk is N/2 due to the previously mentioned symmetry of data structure in FFT coefficients.

```
6999 REM Save Data to Disk
7000 P=INSTR(FI$,"."): IF FFT.DONE=1 THEN A$=".FFT" ELSE A$=".COR"
7005 IF P=0 THEN OUTFILE$=FI$+A$ ELSE OUTFILE$=MID$(FI$,1,P-1)+A$
7010 PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);"Output File Name (
default is ";OUTFILE$;" )";: A$="": INPUT A$: IF A$<>" THEN
OUTFILE$=A$
7020 OPEN"O",#2,OUTFILE$
7030 NUM.OUT=ORIG.PTS: IF FFT.DONE>0 THEN NUM.OUT=NUM.OUT/2
7040 FOR I=1 TO NUM.OF.PTS: PRINT#2,XP(I),YP(I): NEXT: CLOSE 2
7050 RETURN
```


2.3.9 Apply a Fast Fourier Transform (FFT)

Parameters to be Supplied and Returned:

A(256), AM(256), B(256), FFT.DIR, FFT.DONE, MS\$(50), ORIG.PTS,
NUM.OF.PTS, X(6), XP(256), YP(256)

The FFT algorithm used was obtained from a microcomputing magazine (CREATIVE COMPUTING Jul, 1980). It is a standard FFT function based on having a number of data points which is an integer power of 2. If the number of data points is not equal to such a value (e.g. 2, 4, 8, 16, 32, 64, 128 ...) then sufficient 0's are added to the data set to pad it out to the required length. The current maximum for this length is the data array dimensions which are all 256.

Prior to starting FFT processing the value of the variable FFT.DIR is checked for the required FFT direction. A value of 1 indicates a forward transform is to be done while a value of 2 indicates a reverse or backwards transform. Once a transform has been done, it is necessary to correct the data values in both the A() and B() arrays by dividing by N, the number of data values in the data set. If this is not done prior to doing the opposite transform, wildly incorrect results will be obtained.

Note that the order in which the forward and backward transforms are done in is not significant. The division by N scaling correction is done no matter which direction transform was done first. Note also that once the two transform operations have been completed, it is necessary for the operator to reload the processing arrays prior to doing any further transformations.

The last part of the FFT routine calculates the amplitudes of the constituent frequencies and loads the XP() and YP() plot data arrays. The YP() array is loaded with the amplitudes and the XP() array is loaded with a set of values calculated as $1/T$, where T is the duration of the sampling period in seconds.

NOTE:

In order to properly reload the suggested data maxima and minima, plot segment sizes etc. for the new transformed data set, the FFT subroutine calls part of another routine. Line 11310 includes a "GOSUB 2800". If this FFT routine is extracted for use in any other program, it will be necessary to extract the "2800" subroutine from the other section of the program and include it, renumbered, in this section of the program with the call statement number altered to reflect the change.

```

10999 REM Main FFT Subroutine
11000 M=1: L=0: PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);"Working..."
11010 L=L+1: M=2*M: IF M<ORIG.PTS THEN 11010
11020 N=M: REM N will be LOG2(N)
11025 IF FFT.DONE=0 THEN FOR I=ORIG.PTS+1 TO M: A(I)=0: NEXT
11030 NUM.OF.PTS=N
11040 IS=-1: IF FFT.DIR=2 THEN IS=1
11045 IF FFT.DONE>0 THEN FOR I=1 TO N: A(I)=A(I)/N: B(I)=B(I)/N:
NEXT
11050 T1=2*3.1415927#: FOR I=1 TO N/4+1: P(I)=COS(T1*(I-1)/N):
NEXT: ND2=N/2: ND4=N/4
11060 M=N/2 : R=1
11070 FOR I=1 TO L: FOR J=1 TO R: T=1-R: S=2*M*(J-1): FOR K=1 TO M
11080 S=S+1: X1=A(S): X2=B(S): Y1=A(S+M): Y2=B(S+M): A(S)=X1+Y1:
B(S)=X2+Y2: X1=X1-Y1: X2=X2-Y2: T=T+R: IF T<>1 THEN 11100
11090 Z=S+M: A(Z)=X1: B(Z)=X2: GOTO 11150
11100 IF T-1>=ND4 THEN 11120
11110 U=P(T): V=P(ND4+2-T): GOTO 11130
11120 U=-P(ND2+2-T): V=P(T-ND4)
11130 IF IS<0 THEN V=-V
11140 Z=S+M: A(Z)=U*X1-V*X2: B(Z)=U*X2+V*X1
11150 NEXT : NEXT : M=M/2 : R=R+R : NEXT
11160 REM
11170 REM SHUFFLE ROUTINE to sort the frequency components into
order
11180 REM
11190 FOR I=2 TO N-2 : R=I-1 : J=0 : T=1 : M=N/2
11200 D=INT(R/M) : J=J+D*T : IF M=1 THEN 11220
11210 T=T+T : R=R-M*D : M=M/2 : GOTO 11200
11220 J=J+1 : IF J<=I THEN 11240
11230 SWAP A(I),A(J): SWAP B(I),B(J)
11240 NEXT
11250 REM Routine to Calculate Amplitudes
11260 NUM.OF.PTS=N/2: IF FFT.DONE=1 THEN NUM.OF.PTS=N
11270 FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1: A1=(A(I1)+A(I2))/N:
B1=(-B(I1)+B(I2))/N: AM(I)=SQR(A1*A1+B1*B1): IF FFT.DONE=0 THEN
XP(I)=I/X(2) ELSE XP(I)=I/(2*X(2))
11274 NEXT
11280 REM Find New Data and Plot Limits
11290 FOR I=1 TO NUM.OF.PTS: IF FFT.DONE=1 THEN YP(I)=AM(I) ELSE
YP(I)=A(I)
11300 NEXT
11310 GOSUB 2800: FFT.DONE=(FFT.DONE+1) MOD 2: RETURN

```

2.3.10 Plot the Current Data List

Parameters to be Supplied:

B79\$, NUM.OF.PTS, X(6), X.LABEL\$, XP(256), Y(6), Y.LABEL\$, YP(256)

The plot routine was used as supplied by Dr. R. Hudson with a minimum of changes to correct some minor errors and to help it conform to the variable use conventions of this program.

Some of the significant control variables for setting up the plot are given below:

- A = 1 --> plot points only
- 2 --> plots a curve only
- 3 --> plot both points and the curve

- C = 1 --> Orient the plot across the page
- 2 --> Orient the plot along the page (not implemented)

- D = 1 --> Do not plot a grid
- 2 --> DO plot a grid (not yet implemented)

```
12000 PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);"Ensure the Plotter is  
Attached and Ready : <any key> to Continue": A$=INPUT$(1)
```

```
12010 N.SAVE=N: N=NUM.OF.PTS
```

```
12020 H$=X.LABEL$: V$=Y.LABEL$: C=1: D=1: X1=100: X2=420: Y1=0:
```

```
Y2=480: A=3: XS=X(6): YS=Y(6)
```

```
12030 L1=X(3): R1=X(4): X3=(X(4)-X(3))/X(5): B1=Y(3): T1=Y(4):
```

```
Y3=(Y(4)-Y(3))/Y(5)
```

```
12999 REM Plot Current Data List *****
```

```
13100 REM ***** GENERALISED GRAPH *****
```

```
13110 REM ***** PLOTTING PROGRAMS *****
```

```
13120 REM
```

```
13130 REM
```

```
13140 REM
```

```
13150 REM
```

by
RICK HUDSON

```
13160 REM PROGRAM PERMITS EITHER DATA OR A GRID AND DATA TO BE  
PLOTTED.
```

```
13170 REM THERE ARE A CHOICE OF PEN COLOURS, LINE DOTS, X-Y AXES,  
SCALES
```

```
13180 REM
```

AND LABELS.

```
13190 REM
```

```
13200 REM *****
```

```
13210 REM ORIENT AXIS ALONG/ACROSS THE PAGE
```

```
13220 C=1
```

```
13230 REM *****
```

```
13240 REM CHOOSE EITHER GRID LAYOUT OR NOT.
```

```

13250 D=1
13260 REM *****
13270 REM SET UP BOX SIZE
13280 IF X1<40 OR X2>480 OR Y1<-999 OR Y2>999 THEN 13330
13290 LPRINT CHR$(18)
13300 LPRINT "A"
13310 LPRINT CHR$(18)
13320 GOTO 13370
13330 PRINT: PRINT "*****";
PRINT
13340 PRINT "COORDINATES ARE OUT OF LIMITS. TRY AGAIN"
13350 PRINT: PRINT "*****";
PRINT
13360 STOP
13370 X4=(X2-X1)/X3
13380 Y4=(Y2-Y1)/Y3
13390 LPRINT "C0"
13400 LPRINT "M";X1;",";Y1
13410 LPRINT "X0",";Y4;",";Y3
13420 LPRINT "D";X2;",";Y2;",";X2;",";Y1
13430 LPRINT "M";X1;",";Y1
13440 LPRINT "X1",";X4;",";X3
13450 LPRINT "D";X2;",";Y1
13460 LPRINT "M";X1;",";Y1
13470 LPRINT "I"
13480 REM *****
13490 REM LABEL THE HORIZONTAL AXIS
13500 LPRINT "M50,-60"
13510 LPRINT "S2"
13520 LPRINT "Q0"
13530 LPRINT "P";H$
13540 X5=((R1-L1)/X3)/XS: L2=L1/XS
13550 FOR I=0 TO X3
13560 LPRINT "M";((I*X4)-20);",";-25
13570 LPRINT "S1"
13580 LPRINT "P";L2
13590 L2=L2+X5
13600 NEXT I
13610 REM *****
13620 REM LABEL THE VERTICAL AXIS
13630 LPRINT "M-45,100"
13640 LPRINT "Q3"
13650 LPRINT "S2"
13660 LPRINT "P";V$
13670 LPRINT "H"
13680 Y5=((T1-B1)/Y3)/YS: B2=B1/YS
13690 FOR I=0 TO Y3
13700 LPRINT "M-40,";((I*Y4)-5)
13710 LPRINT "S1"
13720 LPRINT "Q0"
13730 LPRINT "P";B2
13740 B2=B2+Y5

```

```

13750 NEXT I
13760 LPRINT "H"
13770 REM *****
13780 REM SCALE AND PLOT DATA
13790 IF A=2 GOTO 13940
13800 REM *****
13810 REM PLOT * POINTS ONLY
13820 FOR I=1 TO N
13830 X=(XP(I)-L1)*(X2-X1)/(R1-L1):
Y=((YP(I)-B1)*(Y2-Y1)/(T1-B1)): GOSUB 14110
13835 PRINT I,X,Y
13870 LPRINT "M";(X-5);", ";(Y-5): LPRINT "S1": LPRINT "Q0": LPRINT
"P*"
13910 NEXT I
13920 IF A=1, GOTO 14060
13930 REM *****
13940 REM PLOT LINE ONLY
13950 X=(XP(1)-L1)*(X2-X1)/(R1-L1): Y=(YP(1)-B1)*(Y2-Y1)/(T1-B1):
GOSUB 14110: LPRINT "M";X;", ";Y
13990 FOR I=2 TO N
14000 X=(XP(I)-L1)*(X2-X1)/(R1-L1): Y=(YP(I)-B1)*(Y2-Y1)/(T1-B1):
GOSUB 14110: LPRINT "D";X;", ";Y
14040 NEXT I
14050 LPRINT "H"
14060 N=N.SAVE: RETURN
14070 PRINT "THIS PART OF THE PROGRAM IS NOT WRITTEN YET"
14080 PRINT " "
14090 PRINT "TYPE A '1' INSTEAD OF A '0' FOR THIS QUESTION"
14100 STOP
14110 IF X<0 THEN X=0 ELSE IF X>(X2-X1) THEN X=X2
14120 IF Y<0 THEN Y=0 ELSE IF Y>(Y2-Y1) THEN Y=Y2
14130 RETURN

```


2.3.11 Perform Correlation Analysis

Parameters to be Supplied and Returned:

A(256), AM(256), B79\$, NUM.OF.PTS, STEP., AM(), XP(), YP()

This routine performs a standard autocorrelation analysis on the data set loaded into the processing arrays. Unlike the FFT process, this routine does not assume any symmetry in the data set. However, the autocorrelation process does assume uniformly spaced data points. If the data as originally obtained from the file is not evenly spaced, then it is up to the user to subject it to the linear interpolation routine. The latter will insure that the data in the processing arrays is uniformly spaced.

The correlation process basically works by comparing a data set with itself offset by a user specified amount. In this case the user specifies the offset in Hz. while the increments in the X direction are $1/(X \text{ range})$ Hz. in size. This means that in stepping through the total offset requested, $(\text{user offset})/(\text{step size})$ number of loop iterations are needed.

The results are passed back in the XP() and YP() arrays and the number of points is updated to the number of steps calculated as necessary to cover the user requested offset.

Note that a section of code contained in another module, 28xx, is called from this routine to recalculate the data set limits and the program suggested plot range limits. Should this module be removed from this program for use elsewhere ensure that the routine called, 2800-2890, is copied and renumbered to fit into this module. Ensure that the "GOSUB" statement number is corrected in such a case.

Subroutine 15000 as shown below is a relatively direct incorporation of the correlation analysis process. All of the sums required are performed within a single loop. This is followed by a calculation of the final correlation coefficient. This was the first incorporation of this algorithm. This program segment is being left in the documentation even though it is not in the program listing in order to assist the reader with understanding the actual function of subroutine 17000 as explained below.

```
14999 REM Subroutine to do autocorellation on shifted data array
15000 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Working...."
15010 XINC=(X(2)-X(1))/NUM.OF.PTS: FSTEP=INT((STEP./XINC)+.5):
N=NUM.OF.PTS
15100 FOR I=1 TO FSTEP: SX=0: SY=0: SX2=0: SY2=0: SXY=0
```

```

15110 PRINT FNS$(15,16);"STEP: ";I;"  "
15120 FOR J=1 TO N-I: JI=J+I: SXY=SXY+A(J)*A(JI): SX=SX+A(J):
SY=SY+A(JI): SX2=SX2+A(J)*A(J): SY2=SY2+A(JI)*A(JI): NEXT
15150 AM(I)=((N-I)*SXY-SX*SY)/SQR(((N-I)*SX2-SX*SX)*
((N-I)*SY2-SY*SY)): YP(I)=AM(I): XP(I)=I*XINC
15160 NEXT: NUM.OF.PTS=FSTEP
15170 GOSUB 2800: RETURN

```

However, since this process is being applied on a data array relative to itself, it is possible to precalculate most of the sums used. That is, the sums of the "Y"'s and of the "X"'s are the same over the entire range of data. These same sums can be produced much more efficiently by producing a single total sum for all of the data points and then subtracting a single value from this total rather than adding a series of numbers to achieve the same total. A new algorithm was encoded to take advantage of the time savings made available by precalculating the sums. This was added into the program as subroutine 17000. The original subroutine 15000 was removed from the final version of the program once the enhanced code was properly tested.

```

17000 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Working...."
17002 FOR I=0 TO NUM.OF.PTS: A(I)=YP(I): NEXT
17010 XINC=(X(2)-X(1))/NUM.OF.PTS: FSTEP=INT((STEP./XINC)+.5):
N=NUM.OF.PTS
17020 SX=0: SX2=0: FOR I=1 TO N: B(I)=A(I)*A(I): SX2=SX2+B(I):
SX=SX+A(I): NEXT
17030 SY2=SX2: SY=SX
17040 FOR I=1 TO FSTEP: SXY=0: FOR J=1 TO N-I:
SXY=SXY+A(J)*A(J+I): NEXT: K=N-I
17045 PRINT FNS$(15,16);"STEP: ";I;"  "
17050 SX2=SX2-B(K+1): SY2=SY2-B(I): SX=SX-A(K+1): SY=SY-A(I)
17060 MP(I)=(K*SXY-SX*SY)/SQR((K*SX2-SX*SX)*(K*SY2-SY*SY)):
YP(I)=MP(I): XP(I)=I*XINC: NEXT
17070 NUM.OF.PTS=FSTEP: GOSUB 2800: RETURN

```

2.3.12 Generate Linearly Interpolated Data

Parameters to be Supplied and Returned:

A(256), B(256), B79\$, NUM, X(6), XP(256), YP(256)

This routine performs a simple linear interpolation on the data in the processing arrays. The user supplies the number of data points to be provided in the final data set. After calculating the X increment for the interpolated data set, the actual difference between adjacent X values is compared and a suitable fraction of the Y value is taken for that interpolated X value. This process is continued, jumping to the next pair of X values until the entire X range has been accommodated.

The results are passed back in the A(), XP() B(), and YP() arrays and the number of points is updated to the number of points requested by the user.

Note that a section of code contained in another module, 28xx, is called from this routine to recalculate the data set limits and the program suggested plot range limits. Should this module be removed from this program for use elsewhere ensure that the routine called, 2800-2890, is copied and renumbered to fit into this module. Ensure that the "GOSUB" statement number is corrected in such a case.

```
15999 REM Subroutine to produce interpolated data
16000 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Working...."
16010 J=2: XINC=(X(2)-X(1))/NUM: YP(1)=A(1): X=XP(1): B(1)=X
16020 FOR K=2 TO NUM: X=X+XINC
16025 IF X>XP(J) THEN J=J+1: GOTO 16025
16030 I=J-1: YP(K)=A(I)+((A(J)-A(I))*(X-XP(I))/(XP(J)-XP(I))):
B(K)=X
16040 NEXT: NUM.OF.PTS=NUM
16050 FOR I=1 TO NUM: A(I)=YP(I): XP(I)=B(I): B(I)=0: NEXT
: GOSUB 2800
16060 RETURN
```

3.0 Data File Description

The following is a listing of a typical data file. It has two or more values in sequence separated by commas. The program as currently written will only read the first two of however many numbers there are in a record. Since the file is expected to be formatted, that is, a terminal format file, a record is assumed to be one line in the file. A data file can have a maximum of 256 records and the accuracy of the numbers is typically significant to 6 figures. This is the accuracy limit of single precision MICROSOFT Basic and a Z80 CPU.

```
680,0
900,7.5
1000,9.5
1100,11.5
1370,20.8
1480,20.8
1640,16.5
2100,30.7
2200,30.9
2300,30
2500,27
3080,0
3450,33
4750,45.5
5300,46.7
6000,55
6500,59.2
6900,61
7400,66.3
7600,67
7880,67
8930,60
10000,50
```

4.0 Program Listing


```

100 DEFINT T,R
170 DIM A(256),B(256),MP(256),P(50)
180 I=0: J=0: SXY=0: SX=0: SY=0: SX2=0: SY2=0: X.INC=0: STEP.=0: T=0: R=0: S=0: M
190: K=0: X1=0: X2=0: Y1=0: Y2=0: Z=0: Z1=0: Z2=0: ND
200: ND4=0: N=0: U=0: V=0: IS=0: D=0
190 DIM T1(256),T2(256),XP(256),YP(256),MS$(50),FFT.DIR$(2),REJ(256),FLAG$(1),X(
,Y(6)
200 SELECT$="Select Required Action Via Corresponding Number :": LOAD.MODE=-1: F
I$="None Selected": B79$=STRING$(79,32): LIN=16: B25
=STRING$(25,32)
210 X.LABEL$="X - Axis": Y.LABEL$="Y - Axis": FILTER.TYPE$="No Filter Selected":
FFT.DIR$(0)=" ": FFT.DIR$(1)="Forward": FFT.DIR$(2)=
"Backward": FLAG$(0)=" ": FLAG$(1)="**"
220 X(6)=1: Y(6)=1
220 DEF FNS$(X,Y)=CHR$(30)+STRING$(Y,10)+STRING$(X,12)
230 FFT.DIR=1: STEP.=1000: NUM=64
240 PRINT.FLAG=0: DATA.MASK$="####          #####.###          #####.###          #####.###.###
#####.####": CLS$=CHR$(26)
250 OUT.MASK$=STRING$(10,32)+"#### \ \ #####.###          #####.###          #####.####": DR
OP.MASK$=STRING$(32,32)+"####   ##.###   ##.####   #
#####
260 DES.MASK$="\ \#####.#### #####.#### #####.#### #####.#### #####.#### \
\
270 FOR I=1 TO 43: READ MS$(I): NEXT
280 PRINT CLS$:TAB(20):"Acoustic Signature Analysis - V2.0": PRINT TAB(20):STRIN
G$(34,"-"): PRINT: PRINT
290 FOR I=1 TO 6: LINE.=2+2*I: PRINT FNS$(0,LINE.):MS$(I);FNS$(40,LINE.):MS$(I+6
NEXT
300 PRINT FNS$(0,18);STRING$(78,"-")
310 PRINT "Data File: ";FI$:TAB(30):"FFT Direction: ";FFT.DIR$(FFT.DIR):" Corr
Step (hz): ";STEP.: PRINT
320 PRINT "Filter: ";FILTER.TYPE$:TAB(40):"Factor: ";FILTER.VAL;" Num. Pts.: "
;NUM.OF.PTS;" N: ";N: PRINT FNS$(0,23):"Linear Inte
polation Pts.: ";NUM;
330 PRINT FNS$(0,0)
330 PRINT FNS$(5,16);SELECT$;: PRINT FNS$(55,16);: INPUT ACT
340 IF ACT<0 OR ACT>11 THEN 280
350 IF ACT=11 THEN END
360 ON ACT+1 GOSUB 1000,2000,3000,4000,5000,6000,11000,12000,7000,16000,17000
370 GOTO 280
380 FOR I=LINE. TO 22: PRINT FNS$(0,I);STRING$(79,32): NEXT: RETURN
390 DATA "0) Read Data File","1) Load Data for Processing","2) Access Data Descr
iption Parameters"
400 DATA "3) Access Processing Parameters","4) Print/Display Parameters/Data","5
Apply Selected Filter","6) Apply Fourier Transform
410 DATA "7) Plot Current Data List","8) Save Current Data List To Disk","9) Gen
erate Interpolated Data"
420 DATA "10) Perform Correlation Analysis","11) Exit"
999 REM Read Data File *****
1000 PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);: INPUT"Enter Data File Name: ";FI$
1002 CO=2: PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);: INPUT"No of Columns in Data Fil
e. ";CO: IF CO<=0 THEN CO=2
1010 OPEN"1",#1,FI$ : I=1: FFT.DONE=0
1020 IF EOF(1) THEN CLOSE 1: LOAD.MODE=0: NUM.OF.PTS=I-1: ORIG.PTS=NUM.OF.PTS: G
OTO 1080
1030 IF I=2 THEN T1.MIN=T1(1): T1.MAX=T1(1): T2.MIN=T2(1): T2.MAX=T2(1)
1040 IF CO>=2 THEN INPUT#1,T1(I),T2(I) ELSE INPUT#1,T1(I)
1050 IF T1(I)<T1.MIN THEN T1.MIN=T1(I) ELSE IF T1(I)>T1.MAX THEN T1.MAX=T1(I)

```

```

1060 IF CO>=2 THEN IF T2(I)<T2.MIN THEN T2.MIN=T2(I) ELSE IF T2(I)>T2.MAX THEN T
2.MAX=T2(I)
1070 I=I+1: GOTO 1020
1080 VALUE=T1.MAX: GOSUB 1900: TD1=TOP.VAL
1082 IF CO=1 THEN T=(X(2)-X(1))/(NUM.OF.PTS-1): FOR I=0 TO NUM.OF.PTS-1: T2(I)=X
(1)+T*I: NEXT: T2.MIN=T2(1): T2.MAX=T2(NUM.OF.PTS)
1090 VALUE=T2.MAX: GOSUB 1900: TD2=TOP.VAL
1100 RETURN
1900 M=.00001: L=0: SIGN=1: IF VALUE<0 THEN SIGN=-1
1905 VALUE=ABS(VALUE)
1910 L=L+1: M=10*M: IF M<VALUE THEN 1910
1920 M.M=1: L.L=0: M=M/10: IF M>=1 THEN M=INT(M)
1930 L.L=L.L+1: M.M=L.L*M: IF M.M<VALUE THEN 1930
1940 TOP.VAL=SIGN*M.M: RETURN
1999 REM Load Data for Processing *****
2000 PRINT CLS#:FNS$(20,0);"Load Data for Processing";FNS$(20,1);STRING$(24,"-")
: PRINT: PRINT
2010 FOR I=13 TO 15: LINE.=3+(I-13)*2: PRINT FNS$(10,LINE.);MS$(I): NEXT
2012 PRINT FNS$(0,14);STRING$(78,"-"): PRINT
2015 IF LOAD.MODE<=0 THEN PRINT FNS$(15,16);"No Data File Loaded Yet": PRINT
2020 IF LOAD.MODE=1 THEN PRINT FNS$(15,16);"Field 1 { H() } ---->> Processing
Array { A() }": PRINT
2030 IF LOAD.MODE=2 THEN PRINT FNS$(15,16);"Field 2 { V() } ---->> Processing
Array { A() }": PRINT
2035 PRINT STRING$(78,"-")
2040 PRINT FNS$(5,10);SELECT$: INPUT ACT
2050 IF ACT<1 OR ACT>3 THEN 2000
2055 IF ACT=3 THEN RETURN
2060 LOAD.MODE=ACT: FFT.DONE=0: NUM.OF.PTS=ORIG.PTS
2090 PRINT FNS$(0,16);B79#:FNS$(15,16);"Loading...": NUM.OF.PTS=ORIG.PTS: ON LD
AD.MODE GOTO 2100,2200
2100 FOR I=1 TO ORIG.PTS: YP(I)=T1(I): A(I)=T1(I): XP(I)=T2(I): NEXT: GOSUB 2800
: GOTO 2015
2200 FOR I=1 TO ORIG.PTS: YP(I)=T2(I): A(I)=T2(I): XP(I)=T1(I): NEXT: GOSUB 2800
: GOTO 2015
2230 DATA "1 - Load Array H (first field in file record) for Processing","2 - Lo
ad Array V (second field in file record) for Process
ing"
2240 DATA "3 - Return to Main Menu"
2800 T1.MIN=YP(1): T1.MAX=YP(1): T2.MIN=XP(1): T2.MAX=XP(1)
2810 FOR I=1 TO NUM.OF.PTS
2820 IF YP(I)<T1.MIN THEN T1.MIN=YP(I) ELSE IF YP(I)>T1.MAX THEN T1.MAX=YP(I)
2830 IF XP(I)<T2.MIN THEN T2.MIN=XP(I) ELSE IF XP(I)>T2.MAX THEN T2.MAX=XP(I)
2840 NEXT
2850 VALUE=T1.MAX: GOSUB 1900: TD1=TOP.VAL: VALUE=T1.MIN: GOSUB 1900: TL1=TOP.VA
L-TOP.VAL/10
2860 VALUE=T2.MAX: GOSUB 1900: TD2=TOP.VAL: VALUE=T2.MIN: GOSUB 1900: TL2=TOP.VA
L-TOP.VAL/10
2870 Y(1)=T1.MIN: Y(2)=T1.MAX: Y(3)=TL1: Y(4)=TD1: Y(5)=(TD1-TL1)/5
2880 X(1)=T2.MIN: X(2)=T2.MAX: X(3)=TL2: X(4)=TD2: X(5)=(TD2-TL2)/5
2890 RETURN
2999 REM Access Data Description Parameters *****
3000 PRINT CLS#:FNS$(20,0);"Display/Edit Data Description Parameters";FNS$(20,1)
;STRING$(40,"-"): COL=0
3010 FOR I=16 TO 22: LINE.=2+(I-16)*2: PRINT FNS$(10,LINE.);MS$(I);FNS$(40,LINE.
);MS$(I+7): NEXT: PRINT FNS$(60,2);"15 - Return to"
;FNS$(65,3);"Main Menu":
3020 PRINT FNS$(COL+23,18);"Axis Axis Axis Plot": PRINT FNS$(COL+7,19);
"Min Max Min Max Seg Scale Lab
el": PRINT FNS$(COL,21);"X";FNS$(COL,22);"Y":
3030 GOSUB 3700
3040 PRINT FNS$(10,16);SELECT$: INPUT ANS: IF ANS<1 OR ANS >15 THEN 3040 ELSE I
F ANS=15 THEN RETURN
3100 IF ANS>7 THEN 3200 ELSE M$=MS$(15+ANS): GOSUB 3800: IF ANS=7 THEN X.LABEL$=
VALUE$: GOTO 3240
3110 ON ANS GOTO 3120,3120,3130,3130,3120,3120

```

```

3120 X(ANS)=VALUE: GOTO 3240
3130 X(ANS)=VALUE: X(5)=(X(4)-X(3))/5: GOTO 3240
3200 M#=MS$(15+ANS): ANS=ANS-7: GOSUB 3800: IF ANS = 7 THEN Y.LABEL#=VALUE#
3210 ON ANS GOTO 3220,3220,3230,3230,3220
3220 Y(ANS)=VALUE: GOTO 3240
3230 Y(ANS)=VALUE: Y(5)=(Y(4)-Y(3))/5: GOTO 3240
3240 GOSUB 3700: GOTO 3040
3700 PRINT FNS$(COL+1,21);STRING$(78,32);FNS$(COL+1,22);STRING$(78,32);
3710 FOR I=1 TO 6: POS.=COL+I*8-2: PRINT FNS$(POS.,21);X(I);FNS$(POS.,22);Y(I);:
NEXT: POS.=COL+55
3720 PRINT FNS$(POS.,21);X.LABEL#;FNS$(POS.,22);Y.LABEL#;: RETURN
3800 PRINT FNS$(10,16);STRING$(60,32);FNS$(10,16);"Enter New ";MID$(M$,4);: INPUT
VALUE#: IF ANS<>7 THEN VALUE=VAL(VALUE#)
3810 RETURN
3900 DATA "1 - Minimum X","2 - Maximum X","3 - X-Axis Minimum","4 - X-Axis Maximum",
"5 - X-Axis Segment Size","6 - X Plot Scale Factor",
"7 - X-Axis Label"
3910 DATA "8 - Minimum Y","9 - Maximum Y","10 - Y-Axis Minimum","11 - Y-Axis Maximum",
"12 - Y-Axis Segment Size","13 - Y Plot Scale Factor",
"14 - Y-Axis Label"
3999 REM Access Processing Parameters *****
4000 PRINT CLS#;FNS$(20,0);"Display/Edit Processing Parameters";FNS$(20,1);STRING$(34,"-"): COL=10: BLIN=18
4010 FOR I=30 TO 36: LINE.=4+(I-30)*2: PRINT FNS$(5,LINE.);MS$(I): NEXT
4020 PRINT FNS$(50,3);"PREVIOUS CURRENT": GOSUB 4800
4030 PRINT FNS$(0,BLIN);STRING$(79,32);FNS$(10,BLIN);SELECT#;: INPUT ANS: IF ANS
<1 OR ANS>7 THEN 4030 ELSE IF ANS=7 THEN RETURN
4040 ON ANS GOSUB 4060,4100,4200,4500,4550,4580: LINE.=BLIN: GOSUB 800: GOTO 402
4060 LINE.=BLIN: PROMPT#=MID$(MS$(30),5): GOSUB 4700: IF A#="" THEN RETURN ELSE
OLD.MIN.AMP=MIN.AMP: MIN.AMP=VAL(A#): RETURN
4100 PRINT FNS$(0,BLIN-1);STRING$(79,"-"): LINE.=BLIN+0: FOR I=0 TO 1: POS.=LINE
+2*I: PRINT FNS$(0,POS.);MS$(37+I);TAB(40);MS$(39+I)
7: NEXT
4110 PRINT FNS$(5,LINE.+4);"Select Number Corresponding to Desired Filter Type";
INPUT ANS: IF ANS<1 OR ANS>4 THEN 4110 ELSE OLD.FILTER=FILTER: FILTER=ANS
4120 FILTER.TYPE#=MID$(MS$(36+ANS),5): PRINT FNS$(0,BLIN-1);B79#: RETURN
4200 IF FILTER=0 THEN PRINT FNS$(10,LINE.);"Select a Filter Type First! (type <
RETURN> to Continue)";: INPUT A: RETURN
4210 ON FILTER GOSUB 4220,4300,4400: RETURN
4220 LINE.=BLIN: PROMPT#="Component No. to be Deleted ": GOSUB 4700: IF A#="" TH
EN RETURN ELSE V=VAL(A#): A(V)=0: B(V)=0: REJ(V)=1:
GOTO 4220
4300 LINE.=BLIN: PROMPT#="Enter Min. Amp. Rejection Threshold ": GOSUB 4700: IF
A#="" THEN RETURN ELSE OLD.FILTER.VAL=FILTER.VAL: FI
LTER.VAL=VAL(A#): RETURN
4400 LINE.=BLIN: PROMPT#="Enter Exponential Factor F in ( 1 / EXP(i*F/N) ) ": GO
SUB 4700: IF A#="" THEN RETURN ELSE OLD.FILTER.VAL=F
ILTER.VAL: FILTER.VAL=VAL(A#): RETURN
4500 LINE.=BLIN: PROMPT#="(F)orward or (B)ackward: ": GOSUB 4700: IF A#="" THEN
RETURN
4510 OLD.FFT.DIR=FFT.DIR: IF A#="F" THEN FFT.DIR=1: FFT.DIR#="Forward" ELSE FFT.
DIR=2: FFT.DIR#="Backward"
4520 RETURN
4550 LINE.=BLIN: PROMPT#="Correlation Analysis Step Size in Hz.: ": GOSUB 4700:
IF A#="" THEN RETURN
4560 OLD.STEP=STEP.: STEP.=VAL(A#): RETURN
4580 LINE.=BLIN: PROMPT#="No. of Points in Linear Interpolation: ": GOSUB 4700:
IF A#="" THEN RETURN
4590 OLD.NUM=NUM: NUM=VAL(A#): RETURN
4700 GOSUB 800: PRINT FNS$(10,LINE.);PROMPT#;: A#="": INPUT A#: RETURN
4800 COL=62: LINE.=4: PRINT FNS$(50,LINE.);B25#;FNS$(50,LINE.);OLD.MIN.AMP;FNS$(
COL,LINE.);MIN.AMP
4810 PRINT FNS$(50,LINE.+2);B25#;FNS$(50,LINE.+2);OLD.FILTER;FNS$(COL,LINE.+2);F
ILTER

```



```

4820 PRINT FNS$(50,LINE.+4);STRING$(25,32);FNS$(50,LINE.+4);OLD.FILTER.VAL;FNS$(
COL,LINE.+4);FILTER.VAL
4830 PRINT FNS$(50,LINE.+6);B25$;FNS$(51,LINE.+6);LEFT$(FFT.DIR$(OLD.FFT.DIR),1)
;FNS$(COL+1,LINE.+6);LEFT$(FFT.DIR$(FFT.DIR),1)
4840 PRINT FNS$(50,LINE.+8);B25$;FNS$(50,LINE.+8);OLD.STEP;FNS$(COL,LINE.+8);STE
P.
4845 PRINT FNS$(50,LINE.+10);B25$;FNS$(50,LINE.+10);OLD.NUM;FNS$(COL,LINE.+10);N
UM
4850 PRINT FNS$(35,BLIN-2);STRING$(44,32);FNS$(35,BLIN-2);"< ";FILTER.TYPE$;" >"
4860 RETURN
4900 DATA "1 - Minimum Amplitude for Data List","2 - Select Filter Type","3 - Se
t Filter Parameter(s)","4 - FFT Direction"
4902 DATA "5 - Correlation Analysis Differential (hz)","6 - Number of Points in
Linear Interpolation","7 - Return to Main Menu"
4910 DATA "1 - Selected Component(s) Rejection","2 - Minimum Amplitude Rejection
","3 - Exponential Window Function","4 - No Filterin
g"
4999 REM Print/Display Parameters/Data *****
5000 PRINT CLS$;FNS$(20,0);"Print/Display Parameters and Data";FNS$(20,1);STRING
$(33,"-")
5010 FOR I=41 TO 43: LINE.=3+(I-41)*2: PRINT FNS$(23,LINE.);MS$(I): NEXT
5020 PRINT FNS$(10,LINE.+2);SELECT$;: INPUT ANS: IF ANS<1 OR ANS>3 THEN 5020 ELS
E IF ANS=3 THEN RETURN
5030 ON ANS GOSUB 5100,5500: GOTO 5000
5100 PRINT CLS$;FNS$(0,0);"Component Amplitude Frequency Period Array A
Array B": PRINT FNS$(0,1);STRING$(62,"-"): HOLD=0
5105 NUM.OUT=ORIG.PTS: IF FFT.DONE>0 THEN NUM.OUT=NUM.OF.PTS
5110 FOR I=1 TO NUM.OF.PTS: L=((I-1) MOD 20)+2
5120 PRINT FNS$(0,L);B79$;FNS$(0,L);: PRINT USING DATA.MASK$;I,MP(I),XP(I),YP(I)
,A(I),B(I): PRINT FNS$(0,L+1);B79$
5130 IF L=21 THEN HOLD=1
5140 IF HOLD=1 THEN PRINT FNS$(70,L);: A$=INPUT$(1): IF A$=CHR$(13) THEN HOLD=0
ELSE IF ASC(A$)=27 THEN RETURN
5150 NEXT: A$=INPUT$(1): RETURN
5500 EP$=CHR$(27)+"G": EP.OFF$=CHR$(27)+"H": DC$=CHR$(14): PRINT FNS$(5,9);"Ensue
re That the EPSON or Equivalent Printer is Properly
Attached": PRINT FNS$(20,11);"Type <any key> to Continue": : A$=INPUT$(1)
5510 HH$=CHR$(27)+"<": LPRINT DC$;: Acoustic Signature Analysis": LPRINT: LP
RINT TAB(20);"Source Data File: ";EP$;FI$;EP.OFF$: L
PRINT
5515 LPRINT EP$;TAB(20);"Data Description Parameters": LPRINT TAB(18);STRING$(27
,"-");EP.OFF$: LPRINT
5520 LPRINT TAB(29);"Axis Axis Axis": LPRINT TAB(7);"Min Max
Min Max Seg Label": LPRINT
TAB(3);"-----"
-----"
5530 LPRINT USING DES.MASK$;"X",X(1),X(2),X(3),X(4),X(5),X.LABEL$
5540 LPRINT USING DES.MASK$;"Y",Y(1),Y(2),Y(3),Y(4),Y(5),Y.LABEL$
5550 LPRINT: LPRINT EP$;TAB(20);"Data Processing Parameters": LPRINT TAB(18);STR
ING$(26,"-"): LPRINT EP.OFF$
5560 LPRINT TAB(10);"Minimum Amplitude for Data Listing: ";MIN.AMP: LPRINT
5570 LPRINT TAB(10);"Filter Type: ";FILTER.TYPE$;: IF FILTER<>1 AND FILTER<>4 T
HEN LPRINT TAB(55);"Filter Value: ";FILTER.VAL: LPR
INT
5572 LPRINT TAB(10);"Correlation Analysis Step (Hz): ";STEP.: LPRINT
5574 LPRINT TAB(10);"Number of Original Data Points: ";ORIG.PTS: LPRINT
5576 LPRINT TAB(10);"Number of Linearly Interpolated Points: ";NUM: LPRINT
5580 IF FILTER <>1 OR FILTER <>2 THEN 5700
5585 GOTO 5700
5590 LPRINT "The Following Components were Rejected: Component No. Amplitude
": LPRINT TAB(42);STRING$(24,"-")
5600 FOR I=1 TO REJ(0): LPRINT USING DROP.MASK$;REJ(I),MP(REJ(I)): NEXT: LPRINT:
LPRINT
5700 LPRINT: LPRINT EP$;TAB(20);"List of Current Data": LPRINT TAB(18);STRING$(2
0,"-");EP.OFF$: LPRINT
5730 LPRINT TAB(11);"Element Amplitude Frequency Period (x1000)": LPR

```

```

INT TAB(10);STRING$(57,"-"): COUNT=1
5734 FOR I=1 TO NUM.OF.PTS: FLAG$="" ": IF REJ(COUNT)=I THEN FLAG$="***": COUNT=C
COUNT+1
5740 LPRINT USING OUT.MASK$;I,FLAG$,YP(I),XP(I),1000/XP(I)
5744 NEXT
5760 LPRINT CHR$(12): RETURN
5900 DATA "1 - Display Current Data","2 - Print Parameters/Data","3 - Return to
Main Menu"
5999 REM Apply Selected Filter *****
6000 PRINT FNS$(0,LIN);B79$;FNS$(5,15);"Working...."
6010 ON FILTER GOSUB 6100,6200,6300: RETURN
6100 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Enter Component Number to be Set to ZE
RO ( 0 to QUIT) :"; I=0: INPUT I: IF I<0 OR I>NUM.O
F.PTS THEN PRINT"INVALID COMPONENT NUMBER ***": GOTO 6100
6110 IF I=0 THEN RETURN
6120 IF FFT.DONE=1 THEN GOSUB 6700 ELSE GOSUB 6800
6130 GOTO 6100
6200 REM THIS SUBROUTINE FILTERS BY AMPLITUDE MINIMUM REJECTION
6220 FOR I=1 TO NUM.OF.PTS
6230 IF MP(I)<FILTER.VAL THEN IF FFT.DONE=1 THEN GOSUB 6700 ELSE GOSUB 6800
6240 NEXT
6250 RETURN
6300 REM This subroutine filters by reducing transformed values using an
6310 REM exponential function controlled by the user
6340 IF FILTER.VAL<0 THEN GOTO 6400
6350 REM F=FILTER.VAL: FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1: T=EXP(I*(-F)/NUM
OF.PTS): A(I1)=T*A(I1): A(I2)=T*A(I2): B(I1)=T*B(I
1): B(I2)=T*B(I2): NEXT: RETURN
6352 F=FILTER.VAL: FOR I=1 TO NUM.OF.PTS: T=EXP(I*(-F)/NUM.OF.PTS): A(I)=T*A(I):
B(I)=T*B(I): YP(I)=T*YP(I): NEXT: RETURN
6360 RETURN
6400 F=ABS(FILTER.VAL): FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1: T=EXP((I2)*(-F)
/NUM.OF.PTS): A(I1)=T*A(I1): A(I2)=T*A(I2): B(I1)=T*
A(I1): B(I2)=T*B(I2): NEXT: RETURN
6700 I1=I+1: I2=N-I+1: A(I1)=0: B(I1)=0: A(I2)=0: B(I2)=0: REJ(I1)=1: REJ(I2)=1:
RETURN
6800 A(I)=0: B(I)=0: REJ(I)=1: RETURN
6999 REM Save Data to Disk
7000 P=INSTR(FI$,"."): IF FFT.DONE=1 THEN A$=".FFT" ELSE A$=".COR"
7005 IF P=0 THEN OUTFILE$=FI$+A$ ELSE OUTFILE$=MID$(FI$,1,P-1)+A$
7010 PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);"Output File Name ( default is ";OUTFIL
E$;" )"; A$="": INPUT A$: IF A$<>"" THEN OUTFILE$=A
7020 OPEN"O",#2,OUTFILE$
7030 NUM.OUT=ORIG.PTS: IF FFT.DONE>0 THEN NUM.OUT=NUM.OUT/2
7040 FOR I=1 TO NUM.OF.PTS: PRINT#2,XP(I),YP(I): NEXT: CLOSE 2
7050 RETURN
70999 REM Main FFT Subroutine
11000 M=1: L=0: PRINT FNS$(0,LIN);B79$;FNS$(10,LIN);"Working..."
11010 L=L+1: M=2*M: IF M<ORIG.PTS THEN 11010
11020 N=M: REM N will be LOG2(N)
11025 IF FFT.DONE=0 THEN FOR I=ORIG.PTS+1 TO M: A(I)=0: NEXT
11030 NUM.OF.PTS=N
11040 IS=-1: IF FFT.DIR=2 THEN IS=1
11045 IF FFT.DONE>0 THEN FOR I=1 TO N: A(I)=A(I)/N: B(I)=B(I)/N: NEXT
11050 T1=2*3.1415927#: FOR I=1 TO N/4+1: P(I)=COS(T1*(I-1)/N): NEXT: ND2=N/2: ND
4=N/4
11060 M=N/2: R=1
11070 FOR I=1 TO L: FOR J=1 TO R: T=1-R: S=2*M*(J-1): FOR K=1 TO M
11080 S=S+1: X1=A(S): X2=B(S): Y1=A(S+M): Y2=B(S+M): A(S)=X1+Y1: B(S)=X2+Y2: X1=
-Y1: X2=X2-Y2: T=T+R: IF T<>1 THEN 11100
11090 Z=S+M: A(Z)=X1: B(Z)=X2: GOTO 11150
11100 IF T-1>=ND4 THEN 11120
11110 U=P(T): V=P(ND4+2-T): GOTO 11130
11120 U=-P(ND2+2-T): V=P(T-ND4)
11130 IF IS<0 THEN V=-V

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11140 Z=S+M: A(Z)=U*X1-V*X2: B(Z)=U*X2+V*X1
11150 NEXT : NEXT : M=M/2 : R=R+R : NEXT
11160 REM
11170 REM SHUFFLE ROUTINE to sort the frequency components into order
11180 REM
11190 FOR I=2 TO N-2 : R=I-1 : J=0 : T=1 : M=N/2
11200 D=INT(R/M) : J=J+D*T : IF M=1 THEN 11220
11210 T=T+T : R=R-M*D : M=M/2 : GOTO 11200
11220 J=J+1 : IF J<=I THEN 11240
11230 SWAP A(I),A(J): SWAP B(I),B(J)
11240 NEXT
11250 REM Routine to Calculate Amplitudes
11260 NUM.OF.PTS=N/2: IF FFT.DONE=1 THEN NUM.OF.PTS=N
11270 FOR I=1 TO NUM.OF.PTS: I1=I+1: I2=N-I+1: A1=(A(I1)+A(I2))/N: B1=(-B(I1)+B(I2))/N: MP(I)=SQR(A1*A1+B1*B1): IF FFT.DONE=0 THEN X
P(I)=I/X(2) ELSE XP(I)=I/(2*X(2))
11274 NEXT
11280 REM Find New Data and Plot Limits
11290 FOR I=1 TO NUM.OF.PTS: IF FFT.DONE=1 THEN YP(I)=MP(I) ELSE YP(I)=A(I)
11300 NEXT
11310 GOSUB 2800: FFT.DONE=(FFT.DONE+1) MOD 2: RETURN
12000 PRINT FNS$(0,LIN):B79$:FNS$(10,LIN):"Ensure the Plotter is Attached and Re
ady : <any key> to Continue": A$=INPUT$(1)
12010 N.SAVE=N: N=NUM.OF.PTS
12020 H$=X.LABEL$: V$=Y.LABEL$: C=1: D=1: X1=100: X2=420: Y1=0: Y2=480: A=3: XS=
X(6): YS=Y(6)
12030 L1=X(3): R1=X(4): X3=(X(4)-X(3))/X(5): B1=Y(3): T1=Y(4): Y3=(Y(4)-Y(3))/Y(
5)
12999 REM Plot Current Data List *****
13100 REM ***** GENERALISED GRAPH *****
13110 REM ***** PLOTTING PROGRAMS *****
13120 REM
13130 REM
13140 REM by
13150 REM RICK HUDSON
13160 REM PROGRAM PERMITS EITHER DATA OR A GRID AND DATA TO BE PLOTTED.
13170 REM THERE ARE A CHOICE OF PEN COLOURS, LINE DOTS, X-Y AXES, SCALES
13180 REM AND LABELS.
13190 REM
13200 REM *****
13210 REM ORIENT AXIS ALONG/ACROSS THE PAGE
13220 C=1
13230 REM *****
13240 REM CHOOSE EITHER GRID LAYOUT OR NOT.
13250 D=1
13260 REM *****
13270 REM SET UP BOX SIZE
13280 IF X1<40 OR X2>480 OR Y1<-999 OR Y2>999 THEN 13330
13290 LPRINT CHR$(18)
13300 LPRINT "A"
13310 LPRINT CHR$(18)
13320 GOTO 13370
13330 PRINT: PRINT "*****": PRINT
13340 PRINT "COORDINATES ARE OUT OF LIMITS. TRY AGAIN"
13350 PRINT: PRINT "*****": PRINT
13360 STOP
13370 X4=(X2-X1)/X3
13380 Y4=(Y2-Y1)/Y3
13390 LPRINT "CO"
13400 LPRINT "M";X1;",";Y1
13410 LPRINT "X0",";Y4;",";Y3
13420 LPRINT "C";X2;",";Y2;",";X2;",";Y1
13430 LPRINT "M";X1;",";Y1
13440 LPRINT "X1",";X4;",";X3
13450 LPRINT "D";X2;",";Y1
13460 LPRINT "M";X1;",";Y1

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13470 LPRINT "I"
13480 REM *****
13490 REM LABEL THE HORIZONTAL AXIS
13500 LPRINT "M50,-60"
13510 LPRINT "S2"
13520 LPRINT "Q0"
13530 LPRINT "P";H$
13540 X5=((R1-L1)/X3)/XS: L2=L1/X5
13550 FOR I=0 TO X3
13560 LPRINT "M";((I*X4)-20);",",-25
13570 LPRINT "S1"
13580 LPRINT "P";L2
13590 L2=L2+X5
13600 NEXT I
13610 REM *****
13620 REM LABEL THE VERTICAL AXIS
13630 LPRINT "M-45,100"
13640 LPRINT "Q3"
13650 LPRINT "S2"
13660 LPRINT "P";V$
13670 LPRINT "H"
13680 Y5=((T1-B1)/Y3)/YS: B2=B1/YS
13690 FOR I=0 TO Y3
13700 LPRINT "M-40,";((I*Y4)-5)
13710 LPRINT "S1"
13720 LPRINT "Q0"
13730 LPRINT "P";B2
13740 B2=B2+Y5
13750 NEXT I
13760 LPRINT "H"
13770 REM *****
13780 REM SCALE AND PLOT DATA
13790 IF A=2 GOTO 13940
13800 REM*****
13810 REM PLOT * POINTS ONLY
13820 FOR I=1 TO N
13830 X=(XP(I)-L1)*(X2-X1)/(R1-L1): Y=((YP(I)-B1)*(Y2-Y1)/(T1-B1)): GOSUB 14110
13835 PRINT I,X,Y
13870 LPRINT "M";(X-5);",",;(Y-5): LPRINT "S1": LPRINT "Q0": LPRINT "P*"
13910 NEXT I
13920 IF A=1 THEN 14060
13930 REM*****
13940 REM PLOT LINE ONLY
13950 X=(XP(1)-L1)*(X2-X1)/(R1-L1): Y=(YP(1)-B1)*(Y2-Y1)/(T1-B1): GOSUB 14110: L
PRINT "M";X;",";Y
13990 FOR I=2 TO N
14000 X=(XP(I)-L1)*(X2-X1)/(R1-L1): Y=(YP(I)-B1)*(Y2-Y1)/(T1-B1): GOSUB 14110: L
PRINT "D";X;",";Y
14040 NEXT I
14050 LPRINT "H"
14060 N=N.SAVE: RETURN
14070 PRINT "THIS PART OF THE PROGRAM IS NOT WRITTEN YET"
14080 PRINT " "
14090 PRINT "TYPE A '1' INSTEAD OF A '0' FOR THIS QUESTION"
14100 STOP
14110 IF X<0 THEN X=0 ELSE IF X>(X2-X1) THEN X=X2
14120 IF Y<0 THEN Y=0 ELSE IF Y>(Y2-Y1) THEN Y=Y2
14130 RETURN
15999 REM Subroutine to produce interpolated data
16000 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Working...."
16010 J=2: XINC=(X(2)-X(1))/NUM: YP(1)=A(1): X=XP(1): B(1)=X
16020 FOR K=2 TO NUM: X=X+XINC
16025 IF X>XP(J) THEN J=J+1: GOTO 16025
16030 I=J-1: YP(K)=A(I)+((A(J)-A(I))*(X-XP(I))/(XP(J)-XP(I))): B(K)=X
16040 NEXT: NUM.OF.PTS=NUM
16050 FOR I=1 TO NUM: A(I)=YP(I): XP(I)=B(I): B(I)=0: NEXT: GOSUB 2800

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6060 RETURN
7000 PRINT FNS$(0,LIN);B79$;FNS$(15,LIN);"Working...."
7002 FOR I=0 TO NUM.OF.PTS: A(I)=YP(I): NEXT
7010 XINC=(X(2)-X(1))/NUM.OF.PTS: FSTEP=INT((STEP./XINC)+.5): N=NUM.OF.PTS
7020 SX=0: SX2=0: FOR I=1 TO N: B(I)=A(I)*A(I): SX2=SX2+B(I): SX=SX+A(I): NEXT
7030 SY2=SX2: SY=SX
7040 FOR I=1 TO FSTEP: SXY=0: FOR J=1 TO N-I: SXY=SXY+A(J)*A(J+I): NEXT: K=N-I
7045 PRINT FNS$(15,16);"STEP: ";I;" "
7050 SX2=SX2-B(K+1): SY2=SY2-B(I): SX=SX-A(K+1): SY=SY-A(I)
7060 MP(I)=(K*SXY-SX*SY)/SQR((K*SX2-SX*SX)*(K*SY2-SY*SY)): YP(I)=MP(I): XP(I)=I
XINC: NEXT
7070 NUM.OF.PTS=FSTEP: GOSUB 2800: RETURN
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Cross Reference Listing for File : B:ACANALV2.BAT
 Created at POLAR TECH Ltd., Victoria, B.C.
 on ACANAL Version 2.0
 May 6, 1985

280	340	370				
300	4040	4700				
1000	360					
1020	1070					
1030	1020					
1100	360					
1101	11010					
1110	11080					
1112	11100					
1113	11110					
1115	11090					
1120	11210					
1122	11200					
1124	11220					
1100	360					
1333	13280					
1337	13320					
1394	13790					
1406	13920					
1411	13830	13950	14000			
1600	360					
1602	16025					
1700	360					
1700	1080	1090	2850	2850	2860	2860
1710	1910					
1930	1930					
2000	360	2050				
2015	2100	2200				

2100	2090						
2200	2090						
2800	2100	2200	11310	16050	17070		
3000	360						
3040	3040	3240					
3120	3110	3110	3110	3110			
3130	3110	3110					
3200	3100						
3220	3210	3210	3210				
3230	3210	3210					
3240	3100	3120	3130	3220	3230		
3700	3030	3240					
3800	3100	3200					
4000	360						
4020	4040						
4030	4030						
4060	4040						
4100	4040						
4110	4110						
4200	4040						
4220	4210	4220					
4300	4210						
4400	4210						
4500	4040						
4550	4040						
4580	4040						
4700	4060	4220	4300	4400	4500	4550	4580
4800	4020						
5000	360	5030					
5020	5020						
5100	5030						
5500	5030						
5700	5580	5585					

6000	360							
6100	6010	6100	6130					
6200	6010							
6300	6010							
6400	6340							
6700	6120	6230						
6800	6120	6230						
7000	360							
A	4200	12020	13790	13920				
A\$	4060	4060	4220	4220	4300	4300	4400	4400
	4500	4510	4550	4560	4580	4590	4700	4700
	5140	5140	5140	5150	5500	7000	7000	7005
	7005	7010	7010	7010	7010	12000		
A(SUB)	170	2100	2200	4220	5120	6352	6352	6400
	6400	6400	6400	6700	6700	6800	11025	11045
	11045	11080	11080	11080	11090	11140	11230	11230
	11270	11270	11290	16010	16030	16030	16030	16050
	17002	17020	17020	17020	17040	17040	17050	17050
A1	11270	11270	11270					
ACT	330	340	340	350	360	2040	2050	2050
	2055	2060						
ANS	3040	3040	3040	3040	3100	3100	3100	3110
	3120	3130	3200	3200	3200	3200	3210	3220
	3230	3800	4030	4030	4030	4030	4040	4110
	4110	4110	4110	4120	5020	5020	5020	5020
	5030							
B(SUB)	170	4220	5120	6352	6352	6400	6400	6400
	6400	6700	6700	6800	11045	11045	11080	11080
	11080	11090	11140	11230	11230	11270	11270	16010
	16030	16050	16050	17020	17020	17050	17050	
B1	11270	11270	11270	12030	13680	13680	13830	13830
	13950	13950	14000	14000				
B2	13680	13730	13740	13740				
B25\$	200	4800	4810	4830	4840	4845		
B79\$	200	1000	1002	2090	4120	5120	5120	6000
	6100	7010	11000	12000	16000	17000		
BLIN	4000	4030	4030	4040	4060	4100	4100	4120
	4220	4300	4400	4500	4550	4580	4850	4850
C	12020	13220						
CLS\$	240	280	2000	3000	4000	5000	5100	
CD	1002	1002	1002	1002	1040	1060	1082	

COL	3000 3710 4845	3020 4000	3020 4800	3020 4800	3020 4810	3700 4820	3700 4830	3710 4840
COUNT	5730	5734	5734	5734				
D	180	11200	11200	11210	12020	13250		
DATA.MASK\$	240	5120						
DC\$	5500	5510						
DES.MASK\$	260	5530	5540					
DROP.MASK\$	250	5600						
EP\$	5500	5510	5515	5550	5700			
EP.OFF\$	5500	5510	5515	5550	5700			
F	6352	6352	6400	6400				
FFT.DIR	230	310	4510	4510	4510	4830	11040	
FFT.DIR\$	4510	4510						
FFT.DIR\$(SUB)	190	210	210	210	310	4830	4830	
FFT.DONE	1010 11045	2060 11260	5105 11270	6120 11290	6230 11310	7000 11310	7030	11025
FI\$	200	310	1000	1010	5510	7000	7005	7005
FILTER	4110 5580	4110 6010	4200	4210	4810	5570	5570	5580
FILTER.TYPE\$	210	320	4120	4850	5570			
FILTER.VAL	320 6340	4300 6352	4300 6400	4400	4400	4820	5570	6230
FLAG\$	5734	5734	5740					
FLAG\$(SUB)	190	210	210					
FSTEP	17010	17040	17070					
H\$	12020	13530						
HH\$	5510							
HOLD	5100	5130	5140	5140				
I	180 800 1050 1070 2100 2200 2820 3010 4010 5110 5600 5740	270 1010 1050 1082 2100 2200 2820 3010 4100 5110 5600 6100	270 1020 1050 1082 2100 2200 2830 3710 4100 5120 5600 6100	290 1030 1060 1082 2100 2200 2830 3710 4100 5120 5734 6100	290 1040 1060 2010 2100 2200 2830 3710 4100 5120 5734 6100	290 1040 1060 2010 2100 2810 2830 3710 4010 5010 5120 5740 6110	290 1040 1060 2010 2200 2820 3010 4010 5010 5120 5740 6220	800 1050 1070 2100 2200 2820 3010 4010 5010 5120 5740 6230

	6352	6352	6352	6352	6352	6352	6352	6352
	6400	6400	6400	6700	6700	6800	6800	6800
	7040	7040	7040	11025	11025	11045	11045	11045
	11045	11045	11050	11050	11050	11070	11190	11190
	11220	11230	11230	11270	11270	11270	11270	11270
	11270	11270	11270	11290	11290	11290	11290	11290
	13550	13560	13600	13690	13700	13750	13820	13830
	13830	13835	13910	13990	14000	14000	14040	16030
	16030	16030	16030	16030	16050	16050	16050	16050
	16050	16050	17002	17002	17002	17020	17020	17020
	17020	17020	17020	17040	17040	17040	17040	17045
	17050	17050	17060	17060	17060	17060	17060	
I1	6400	6400	6400	6400	6400	6700	6700	6700
	6700	11270	11270	11270				
I2	6400	6400	6400	6400	6400	6400	6700	6700
	6700	6700	11270	11270	11270			
IS	180	11040	11040	11130				
	180	11070	11070	11190	11200	11200	11220	11220
	11220	11230	11230	16010	16025	16025	16025	16030
	16030	16030	17040	17040	17040			
	180	11070	16020	16030	16030	17040	17050	17050
	17060	17060	17060					
	1900	1910	1910	5110	5120	5120	5120	5130
	5140	11000	11010	11010	11070			
L.L	1920	1930	1930	1930				
L1	12030	13540	13540	13830	13830	13950	13950	14000
	14000							
L2	13540	13580	13590	13590				
IN	200	1000	1000	1002	1002	6000	6100	6100
	7010	7010	11000	11000	12000	12000	16000	16000
	17000	17000						
INE.	290	290	290	800	2010	2010	3010	3010
	3010	4010	4010	4040	4060	4100	4100	4110
	4200	4220	4300	4400	4500	4550	4580	4700
	4800	4800	4800	4800	4810	4810	4810	4820
	4820	4820	4830	4830	4830	4840	4840	4840
	4845	4845	4845	5010	5010	5020		
LOAD. MODE	200	1020	2015	2020	2030	2060	2090	
M	180	1900	1910	1910	1910	1920	1920	1920
	1920	1920	1930	11000	11010	11010	11010	11020
	11025	11060	11070	11070	11080	11080	11090	11140
	11150	11150	11190	11200	11200	11210	11210	11210
M\$	3100	3200	3800					
1. M	1920	1930	1930	1940				
MIN. AMP	4060	4060	4800	5560				
IP (SUB)	170	5120	5600	6230	11270	11290	17060	17060

MS\$ (SUB)	190 3200	270 4010	290 4060	290 4100	2010 4100	3010 4120	3010 5010	3100
N	180 11045 11260 13990	320 11050 11260 14060	6400 11050 11270 17010	6700 11050 11270 17020	11020 11050 11270 17040	11030 11060 12010 17040	11045 11190 12010	11045 11190 13820
N.SAVE	12010	14060						
ND2	180	11050	11120					
ND4	180	11050	11100	11110	11120			
NUM	230 16040	320 16050	4590	4590	4845	5576	16010	16020
NUM.OF.PTS	320 2810 6400 12010	1020 5105 6400 16040	1020 5110 7040 17002	1082 5734 11030 17010	1082 6100 11260 17010	1082 6220 11260 17070	2060 6352 11270	2090 6352 11290
NUM.OUT	5105	5105	7030	7030	7030			
OLD.FFT.DIR	4510	4830						
OLD.FILTER	4110	4810						
OLD.FILTER.VAL	4300	4400	4820					
OLD.MIN.AMP	4060	4800						
OLD.NUM	4590	4845						
OLD.STEP	4560	4840						
ORIG.PTS	1020 11010	2060 11025	2090	2100	2200	5105	5574	7030
OUT.MASK\$	250	5740						
OUTFILE\$	7005	7005	7010	7010	7020			
P	7000	7005	7005					
P (SUB)	170	11050	11110	11110	11120	11120		
POS.	3710	3710	3710	3710	3720	3720	4100	4100
PRINT.FLAG	240							
PROMPT\$	4060	4220	4300	4400	4500	4550	4580	4700
R	160 11150	180 11190	11060 11200	11070 11210	11070 11210	11080	11150	11150
R1	12030	13540	13830	13950	14000			
REJ (SUB)	190 6800	4220	5600	5600	5600	5734	6700	6700
S	180 11080	11070 11080	11080 11090	11080 11140	11080	11080	11080	11080

S*(SUB)	220	290	290	300	320	321	330	330
	800	1000	1000	1002	1002	2000	2000	2010
	2012	2015	2020	2030	2040	2090	2090	3000
	3000	3010	3010	3010	3010	3020	3020	3020
	3020	3040	3700	3700	3710	3710	3720	3720
	3800	3800	4000	4000	4010	4020	4030	4030
	4100	4100	4110	4120	4200	4700	4800	4800
	4800	4810	4810	4810	4820	4820	4820	4830
	4830	4830	4840	4840	4840	4845	4845	4845
	4850	4850	5000	5000	5010	5020	5100	5100
	5120	5120	5120	5140	5500	5500	6000	6000
	6100	6100	7010	7010	11000	11000	12000	12000
	16000	16000	17000	17000	17045			
SELECT*	200	330	2040	3040	4030	5020		
SIGN	1900	1900	1940					
STEP.	180	230	310	4560	4560	4840	5572	17010
SX	180	17020	17020	17020	17030	17050	17050	17060
	17060	17060						
SX2	180	17020	17020	17020	17030	17050	17050	17060
SXY	180	17040	17040	17040	17060			
SY	180	17030	17050	17050	17060	17060	17060	
SY2	180	17030	17050	17050	17060			
T	160	180	1082	1082	6352	6352	6352	6352
	6400	6400	6400	6400	6400	11070	11080	11080
	11080	11100	11110	11110	11120	11120	11190	11200
	11210	11210	11210					
T1	11050	11050	12030	13680	13830	13950	14000	
T1(SUB)	190	1030	1030	1040	1040	1050	1050	1050
	1050	2100	2100	2200				
T1.MAX	1030	1050	1050	1080	2800	2820	2820	2850
	2870							
T1.MIN	1030	1050	1050	2800	2820	2820	2850	2870
T2(SUB)	190	1030	1030	1040	1060	1060	1060	1060
	1082	1082	1082	2100	2200	2200		
T2.MAX	1030	1060	1060	1082	1090	2800	2830	2830
	2860	2880						
T2.MIN	1030	1060	1060	1082	2800	2830	2830	2860
	2880							
TD1	1080	2850	2870	2870				
TD2	1090	2860	2880	2880				
TL1	2850	2870	2870					
TL2	2860	2880	2880					

TOP. VAL	1080 2860	1090	1940	2850	2850	2850	2860	2860
J	180	11110	11120	11140	11140			
/	180 11130	4220 11140	4220 11140	4220	4220	11110	11120	11130
\$	12020	13660						
VALUE	1080 2850	1090 2860	1900 2860	1905 3120	1905 3130	1910 3220	1930 3230	2850 3800
ALUE\$	3100	3200	3800	3800				
	220 14000 16020	220 14110 16025	13830 14110 16030	13835 14110 16030	13870 14110	13950 16010	13950 16010	14000 16020
(SUB)	190 2880 5530 12030 17010	212 2880 5530 12030	1082 3120 5530 12030	1082 3130 5530 12030	1082 3130 5530 12030	2880 3130 11270 16010	2880 3130 11270 16010	2880 3710 12020 17010
INC	180							
LABEL\$	210	3100	3720	5530	12020			
	180 12020 14000	11080 13280 14110	11080 13370	11080 13400	11080 13430	11090 13460	11140 13830	11140 13950
	180 12020 14000	11080 13280 14110	11080 13370 14110	11080 13420	11080 13420	11090 13450	11140 13830	11140 13950
	12030	13370	13440	13540	13550			
	13370	13440	13560					
	13540	13590						
NC	16010	16020	17010	17010	17060			
(SUB)	190 2830 13950 17060	2100 5120 14000	2200 5740 16010	2800 5740 16025	2800 7040 16030	2830 11270 16030	2830 11270 16030	2830 13830 16050
	12020	13540	13540					
	220 14000	220 14120	13830 14120	13835 14120	13870 14120	13950	13950	14000
UB)	190 3230 5540	212 3230 5540	2870 3230 12020	2870 3230 12030	2870 3710 12030	2870 5540 12030	2870 5540 12030	3220 5540 12030
LABEL\$	210	3200	3720	5540	12020			
	180 13420	11080 13430	11080 13450	11080 13460	12020 13830	13280 13950	13380 14000	13400 14120

Y2	180	11080	11080	11080	12020	13280	13380	13420
	13830	13950	14000	14120	14120			

Y3	12030	13380	13410	13680	13690			
----	-------	-------	-------	-------	-------	--	--	--

Y4	13380	13410	13700					
----	-------	-------	-------	--	--	--	--	--

Y5	13680	13740						
----	-------	-------	--	--	--	--	--	--

YP (SUB)	190	2100	2200	2800	2800	2820	2820	2820
	2820	5120	5740	6352	6352	7040	11290	11290
	13830	13950	14000	16010	16030	16050	17002	17060

Y5	12020	13680	13680					
----	-------	-------	-------	--	--	--	--	--

Z	180	11090	11090	11090	11140	11140	11140	
---	-----	-------	-------	-------	-------	-------	-------	--

Z1	180							
----	-----	--	--	--	--	--	--	--

Z2	180							
----	-----	--	--	--	--	--	--	--

APPENDIX II
Hardware Specifications

Select from a complete product line ...

Use Vibro-Meter 500 Series piezoelectric accelerometers for the most accurate measurements of random or repetitive vibration phenomena.

VM 500 Series accelerometers provide a combination of features which enable them to replace traditional charge-coupled piezoelectric accelerometers in low temperature applications (up to 250°F) and, simultaneously, to improve the accuracy of vibration measurements. Each of these units has a built-in preamplifier microcircuit which produces a high level output signal. As a

result, VM accelerometers provide complete freedom from cable noise, cable length limitations, and the need for costly charge amplifiers. Thus, when a user buys a 500 Series accelerometer and a VM power supply, he obtains higher measurement accuracy at a lower cost than that of a charge-coupled accelerometer with its associated charge amplifier.

THE VIBRO-METER CONCEPT— MODELS 501 AND 506

These miniature, high frequency, low mass units are today's smallest accelerometers with built-in preamplifiers. Their exceptionally high flat frequency response sets them apart from any other accelerometer. The Model 501 with grounded case has a guaranteed flat, uniform response to 20 kHz (40 kHz is typical), and the Model 506 with internal case isolation has a guaranteed flat response to 20 kHz ± 1 dB. Both units have a nominal sensitivity of 10 mV/g and have excellent base strain relief.

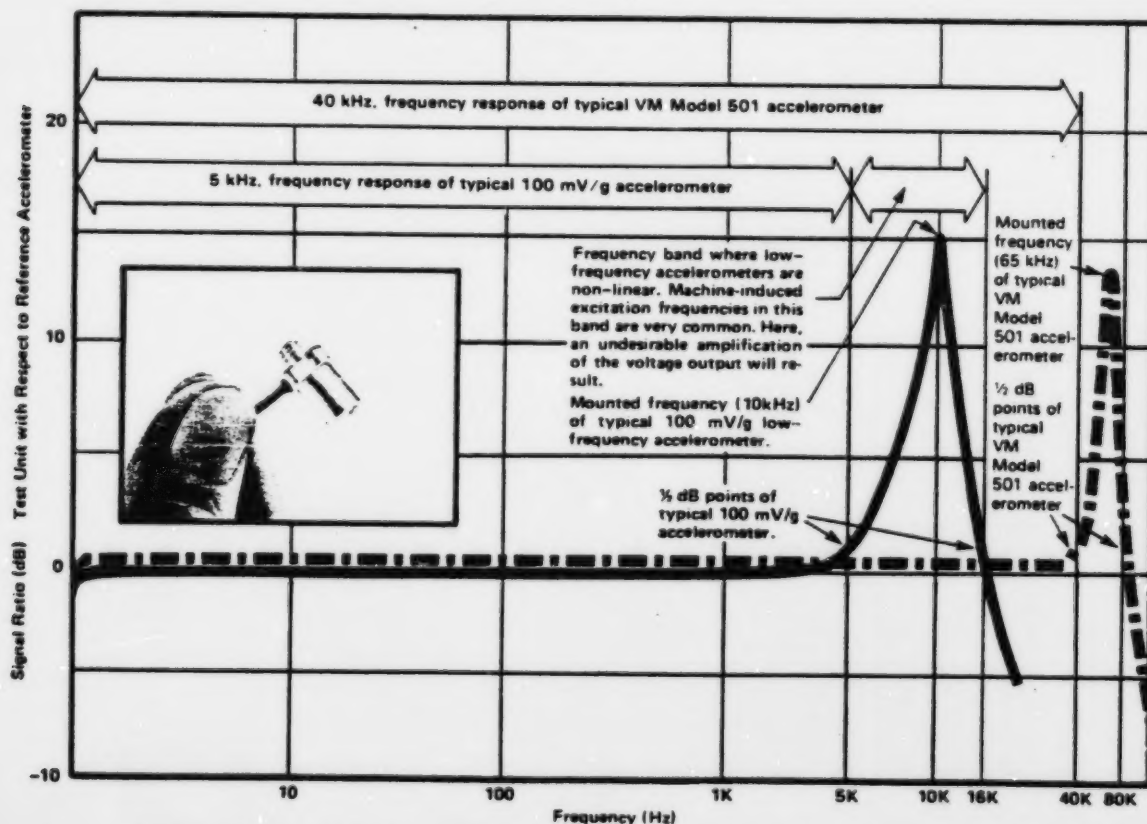
These units are often used as calibration reference accelerometers due to their flat response and intrinsic independence from cable noise effects provided by the built-in preamplifier. Most other commercially available accelerometers are linear to only 3 or 8 kHz at best; therefore, the Models 501 and 506 are superior for use as a calibration reference.

In rotating machinery vibration monitoring applications, the flat frequency response and high resonant frequency of the Models 501 and 506 (65 kHz for the 501 and 55 kHz for the 506) make them an ideal secondary measurement standard in diagnostic work to detect the adverse effects of machine-generated excita-

tion frequencies above the linear range of most accelerometers. The exceptionally broadband, flat frequency response of Models 501 and 506 is linear past the resonant amplification that typical low frequency accelerometers will experience in the band of common machine frequencies. As a result of using the Model 501 or the Model 506 as a diagnostic reference, an unnecessary shutdown may be prevented and a true early warning of impending failure is obtained. Refer to the chart below for a detailed explanation of this concept.

Other applications of Models 501 and 506 include vibration monitoring of inertial guidance systems, satellites, aircraft, and gyroscopes, and vibration testing of printed circuit boards, vibration panels, and shaker tables. Physiological research and voice studies are also areas of application.

In summary, Models 501 and 506 find numerous applications where exceptionally high frequency response is desired, where the mass of the accelerometer must have an absolute minimum effect on the measurement being made, and where space is at a premium.



Frequency response of typical VM Model 501 accelerometer vs. typical 100 mV/g low frequency accelerometer

OBTAIN THESE IMPORTANT FEATURES AND BENEFITS

- Internal preamplifier eliminates cable noise effects, cable length limitations, and costly charge amplifiers.
- Drive up to several hundred feet of cable from accelerometer to oscilloscope, spectrum analyzer, or other output device without degradation in sensitivity.
- New VM Voltage to Charge Converter accessory permits immediate installation of our internally preamplified accelerometers into existing charge amplifier based systems, thus improving the accuracy of vibration measurements (see P-36, P-38 technical data sheets).
- High frequency response — flat up to 25 kHz.

- Wide dynamic range.
- Easy to calibrate — cable motion effects are eliminated.
- No shielding required — accelerometers may be operated in the presence of common, stray, variable magnetic fields at bearing mounts.
- Low cost, constant current power supplies allow direct connection into oscilloscopes or spectrum analyzers.
- Unique 500 V overvoltage protection — the preamplifier is protected against self-generated transients caused by mis-handling or dropping.
- Case grounded or case isolated versions.

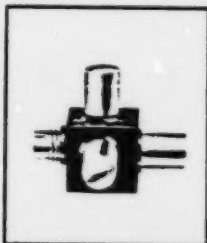
MODELS 501, 501ER, AND 506

Miniature, high frequency, low mass ... See facing page. For extended range operation, see 501ER data sheet.



MODELS 505 AND 505-ISO

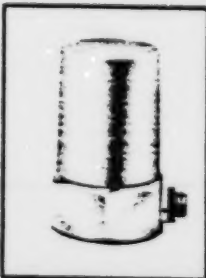
Triaxial, miniature, high frequency, low mass ... These units consist of three accelerometers, one per axis, assembled into a common block. The Model 505 is constructed with three Model 501 accelerometers, and the Model 505-ISO consists of three Model 506 accelerometers. Each triaxial accelerometer provides an X-Y-Z output and a signal common pin on a 4-pin output connector. The Model 505 is case grounded and has a flat frequency response to 18 kHz ± 1 dB. The Model 505-ISO has internal case isolation and has a flat frequency response to 19 kHz ± 1 dB. The Models 505 and 505-ISO are the smallest triaxial accelerometers available today with built-in preamplifiers.



Applications include: vehicle crash testing; drop testing; transportation shock measurement; and vibration monitoring of machine tools, X-ray machines, large rotating machinery, and wherever machine wobble must be monitored and controlled. Models 505 and 505-ISO are particularly suited to applications where there is high transverse axis vibration.

MODEL 507

High sensitivity, low noise floor ... The Model 507 has the lowest noise floor in the industry (0.0002 g rms) and, consequently, it has an exceptionally wide dynamic range. Its 100 mV/g sensitivity provides sufficient signal for low g measurements. Internal impedance matching electronics permits operation with 100 feet of coaxial cable, or more. The Model 507 features base strain relief and a light rugged titanium base for high durability.



Typical applications include sensing for optimization of oil output from oil wells, vibration monitoring in rotating machinery, bearing analysis, test lab measurements, quality control, vehicle testing, and many others.

MODEL 508B

General purpose, low cost ... This is an economical model, and in quantity its low price cannot be matched. Yet there is little compromise in its specifications: flat response to 15 kHz, mounted resonance greater than 45 kHz, and low mass (12 grams).

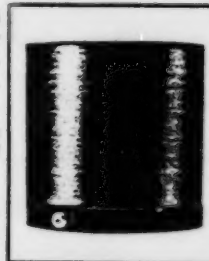
The Model 508B is suited for a wide range of applications including alarm tripping in solid state vibration switches for rotating machinery, weapons testing, destructive testing, general lab use, sound and vibration studies, impact physics, flight tests, and others.



MODEL 510

Seismic ... The Model 510 is a high sensitivity (8 V/g), low noise floor (0.000005 g rms equivalent) accelerometer designed to operate at ultra-low frequencies. The unit has no moving parts. The Model 510 incorporates a built-in preamplifier which can drive hundreds of feet of cable.

Typical applications include measurements in building structures, dams, bridges, towers, or seismic events.



MODELS 524 AND 524-ISO

High sensitivity, OEM ... These accelerometers have a very low noise floor (0.0003 g rms), high sensitivity (100 mV/g) and are compatible with our P-18/4 power supply or several commercially available 4 mA constant current supplies. The higher current supply enables these units to drive longer cable lengths and opens up the dynamic range to ± 50 g peak.

The case is rugged 303 stainless steel and is welded. An MS connector mates to the units at the top.

Applications include high volume requirements for rotating machinery vibration monitoring systems, vibration in machine tools, vehicle testing, and wherever a rugged and inexpensive accelerometer is required.



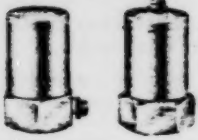
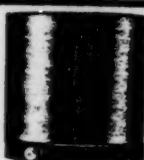
\$350
✓

ns \$310

05623

Accelerometer Specifications

c\$57

High Sensitivity, Low Noise Floor	General Purpose, Low Cost	High Sensitivity, OEM	Seismic
			
Model 507	Model 508B	Model 524-ISO	Model 510
100 mV/g $\pm 5\%$	10 mV/g $\pm 5\%$	100 mV/g $\pm 5\%$	8V/g $\pm 20\%$
+ 10% 0% - 5% - 10% - 15%	+ 10% 0% - 5% - 10% - 15%	+ 10% 0% - 5% - 10% - 15%	50°F to 100°F, $\pm 5\%$ 32°F to 150°F, $\pm 10\%$
5%	5%	5%	3%
20 μ V 0.0002 g-rms	20 μ V 0.0020 g rms	30 μ V 0.0003 g rms	Equivalent to 0.000005 g rms (0.1 to 100 Hz)
$\pm 1\%$ to ± 21 g peak	$\pm 1\%$ to ± 212 g peak	$\pm 1\%$ to ± 25 g peak $\pm 3\%$ to ± 50 g peak	$\pm 1\%$ to ± 0.3 g peak
- 65°F to 250°F ± 21 $\pm 5,000$	- 65°F to 250°F ± 212 $\pm 10,000$	- 65°F to 250°F ± 25 $\pm 5,000$	32°F to 150°F ± 0.25 ± 10 (fragile)
3 to 7,000 Hz 6 to 7,000 Hz 2 to 12,000 Hz	3 to 15,000 Hz 6 to 15,000 Hz 2 to 30,000 Hz	3 to 5,000 Hz 6 to 5,000 Hz 2 to 12,000 Hz	For 32°F to 150°F 0.1 to 125 Hz $\pm 5\%$ 0.03 to 200 Hz ± 3 dB
26 kHz	45 kHz	30 kHz	500 Hz
6 to 4,000 Hz 20 kHz	3 to 8,000 Hz 32 kHz	6 to 3,000 Hz 20 kHz	NOT APPLICABLE
6 to 4,000 Hz 22 kHz	3 to 7,000 Hz 28 kHz	6 to 2,500 Hz 20 kHz	NOT APPLICABLE
1,500 Ω	1,500 Ω	600 Ω	1,500 Ω
Case grounded	Case grounded	Case isolated	Case grounded
0.5 + 5/- 15% 3.5 Vdc	0.5 + 5/- 15% 3.5 Vdc	4.0 $\pm 10\%$ 5 Vdc	0.5 + 5/- 15% 3.5 Vdc
070108 1/4-28 UNC x 0.150"	070108 10-32 UNC x 0.150"	070108 1/4-28 UNC x 0.150"	NOT APPLICABLE
070110 Isolated	070109 Isolated	070110 Isolated	NOT APPLICABLE
Optional	Optional	Optional	Optional
Microdot S-50, female, side mounted	Microdot S-50, female, side mounted	2 Pin, S-2051-10SL-4P	Microdot S-50, female,
Titanium base, SS cap	303SS	303SS, welded, Hermetic connector	Anodized aluminum, black
40 grams	12 grams	100 grams	485 grams
0.75" Hex. x 1.27" H	0.50" Hex. x 0.92" H	1.00" Hex. x 2.10" H	2.00" Dia. x 2.17" H
1/4-28 Tapped hole in base, 0.19" deep	10-32 Tapped hole in base, 0.12" deep	1/4-28 Tapped hole in base, 0.19" deep	1/4-28 Tapped hole in base, 0.30" deep
P-16, P-18, P-18/4*, P-20	P-16, P-18, P-18/4*, P-20	P-18/4	P-16, P-18, P-18/4*

*Use of the P-18/4 power supply affects sensitivity, noise floor, dynamic output impedance, and bias voltage. For a description of the P-18/4, see page 6.

WIBROCORP TEST DATA **vibrometer corp.** Boston, MA USA

NO. 508B-01 - 431
 P.O. NO. _____
 CUSTOMER _____
 MODEL NO. 508B-01
 SERIAL NO. 431
 DATE 8/7/84
 PRODUCTION TEST
 QUALITY CONTROL

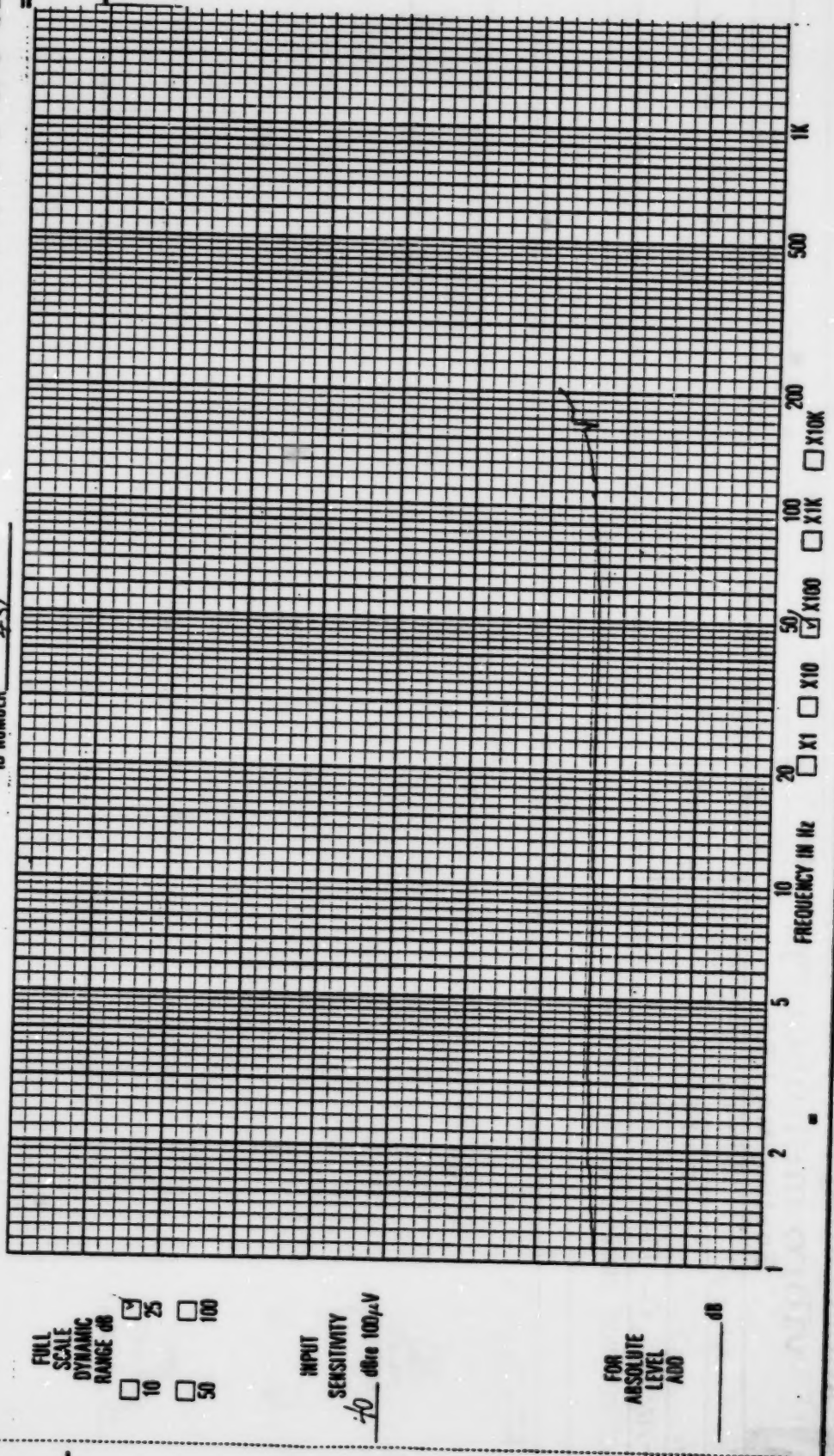
SENSITIVITY: 10.11
 TRANSVERSE SENSITIVITY: 2.5
 NOISE FLOOR: -100.4

OPTIONAL TEST:
 SENSITIVITY VS TEMPERATURE
 % MAX
 %

RESISTANCE Ω
 CAPACITANCE pF
 OTHER TESTS:

FREQUENCY RESPONSE AND/OR OTHER OPTIONAL TESTS:

CHART NO. 1533-0041 FOR USE WITH 1533-P2 SWEEP OSCILLATOR & P2 WAVE ANALYZER
 ID NUMBER 431
 GENRAD, CONCORD, MA 01742 U.S.A.
 PRINTED IN U.S.A.



FULL SCALE DYNAMIC RANGE dB
☐ 10 ☐ 50 ☒ 25 ☐ 100

INPUT SENSITIVITY
 -10 dB re 100 μ V

FOR ABSOLUTE LEVEL ADD



ACCELEROMETER TEST DATA

vibro-meter corp.

Boston, MA USA

FACTORY ORDER NO. _____

P.O. NO. _____

MODEL NO. _____

FILE NO. 508B-01 - 393

CUSTOMER _____

SERIAL NO. 393

OPTIONAL TEST:

SENSITIVITY VS TEMPERATURE

% 5.0 °F

% 101.4 °F

PC/g ☒ m/s²

% MAX

0.001 ☐ 0.01 ☒ 0.1 ☐ 1 ☐ 10 ☐ 100 ☐ 1000

PRODUCTION TEST

DATE 6/4/84

QUALITY CONTROL

DATE _____

REQUENCY RESPONSE AND/OR OTHER OPTIONAL TESTS:

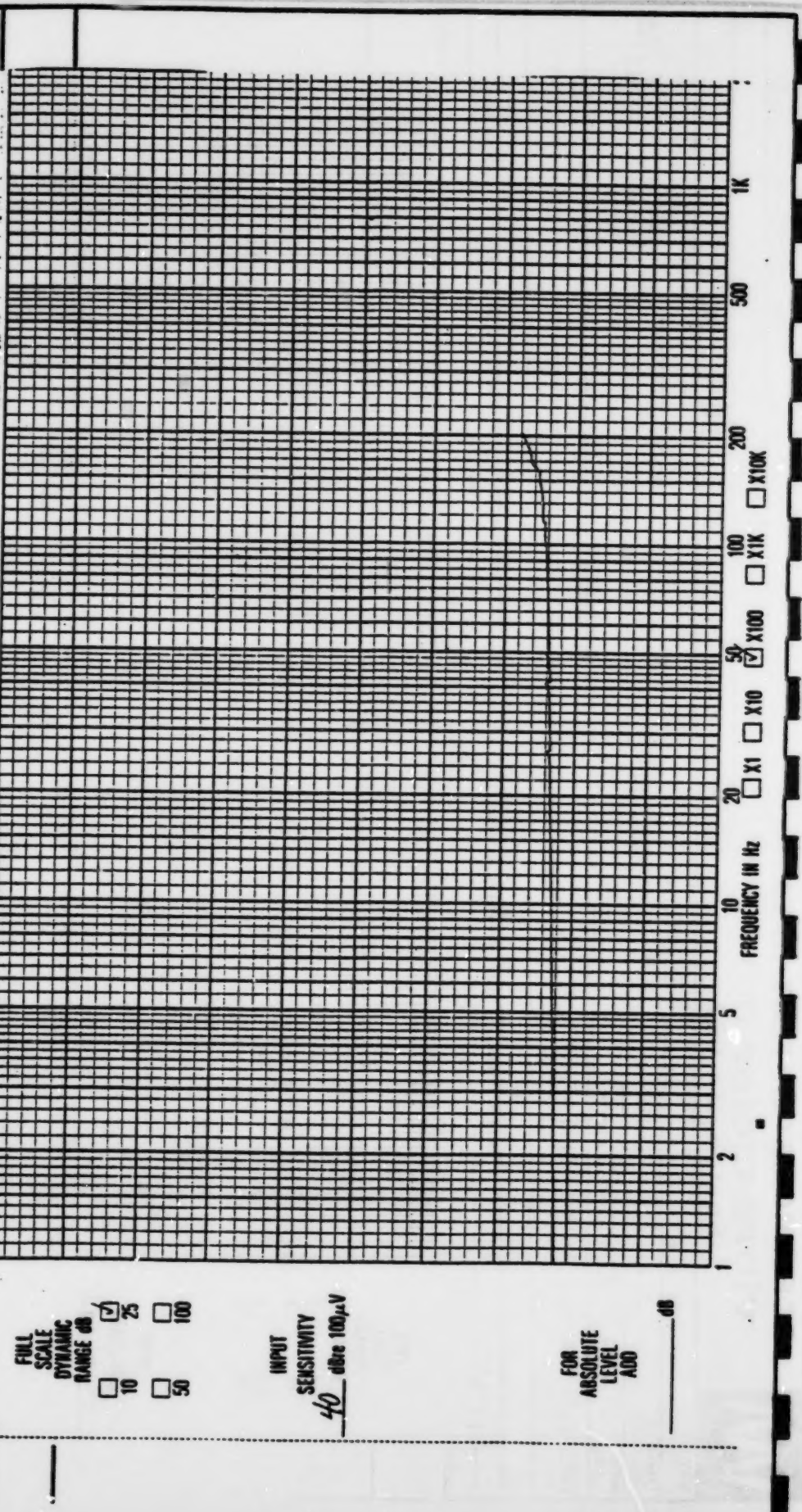
CHART NO. 1333-001 FOR USE WITH 1333-PS SWEEP OSCILLATOR & P4 WAVE ANALYZER

50% IN

ID NUMBER 393

GENRAD, CONCORD, MA 01742 U.S.A.

PRINTED IN U.S.A.





ACCELEROMETER TEST DATA
vibro-meter corp.
Boston, MA USA

FACTORY
ORDER NO.

P.O. NO.

MODEL
NO.

SENSITIVITY: 10.43

TRANSVERSE
SENSITIVITY: 2.7

NOISE
FLOOR: 100.6

pc/g
mv/g

% MAX

uv

dbv

g equiv

OPTIONAL TEST:
SENSITIVITY VS TEMPERATURE

%

%

%

RESISTANCE

Ω

CAPACITANCE

pf

OTHER
TESTS:

SERIAL
NO.

508B-01

CUSTOMER

508B-01 - 434

PRODUCTION TEST

QUALITY CONTROL

DATE

8/7/84

FREQUENCY RESPONSE AND/OR OTHER OPTIONAL TESTS:

50% 1/11

CHART NO. 1823-0461

FOR USE WITH 1823-P3 SWEEP OSCILLATOR & P4 WAVE ANALYZER

GENRAD, CONCORD, MA. 01742 U.S.A.

PRINTED IN U.S.A.

ID NUMBER

747

FULL
SCALE
DYNAMIC
RANGE db

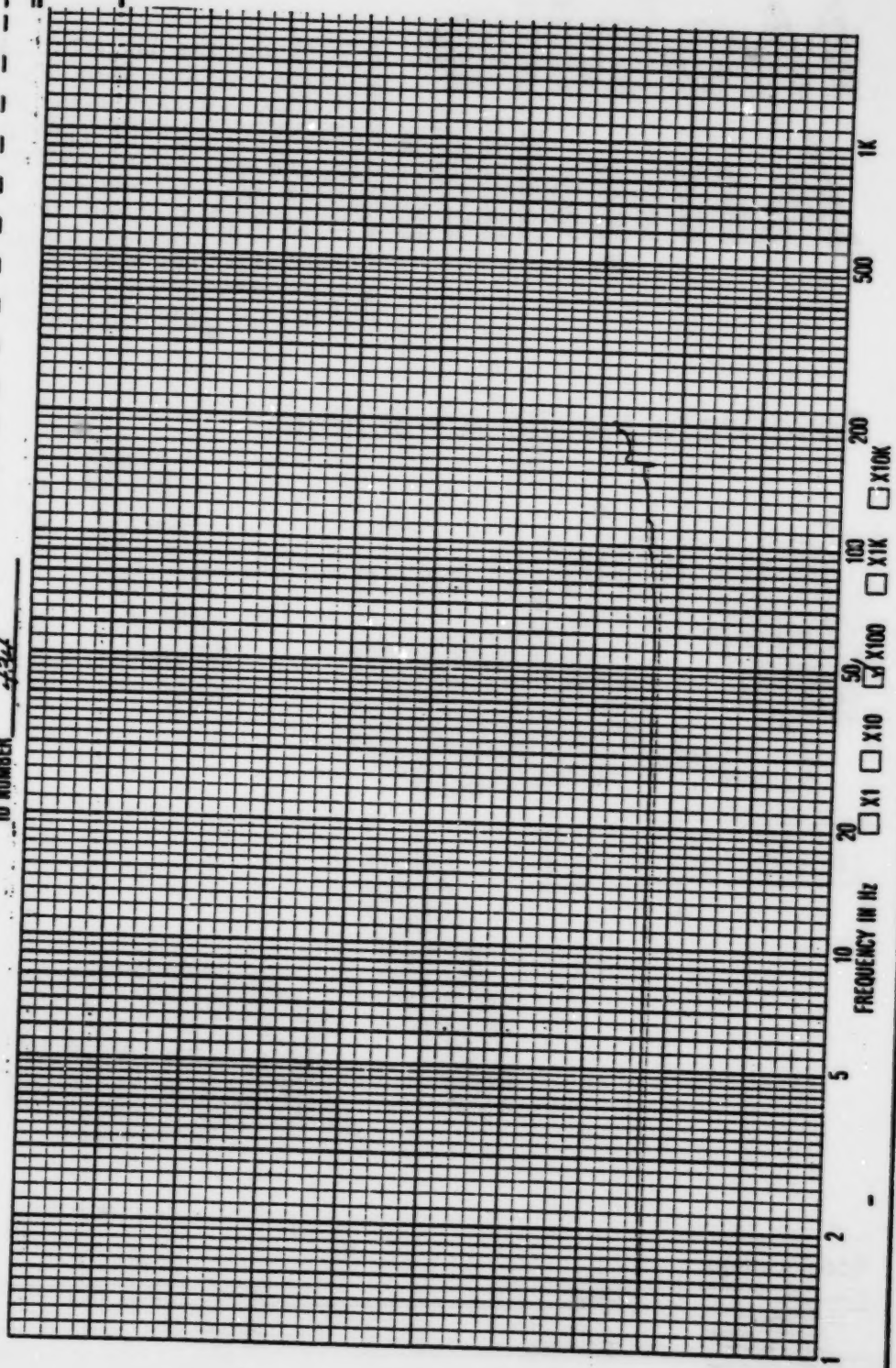
☐ 10 ☒ 25 ☐ 50 ☐ 100

INPUT
SENSITIVITY

40 dbre 100μV

FOR
ABSOLUTE
LEVEL
ADD

db



Mobile Amplifiers

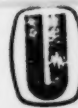
A Comprehensive Range To Suit Any Situation
 Different situations need different amplifiers. That is why TOA designs a comprehensive range of mobile amplifiers. Each is a top performer, painstakingly developed with a keen eye for quality, versatility and convenience. TOA amplifiers and boosters give you output potential ranging from a modest 10W to a powerful 480W. Each model can be depended on to deliver clear, crisp and precise reproduction. For every mobile amplifier situation, TOA has the perfect solution.

Solid State Mobile Amplifiers



Specifications

Model No.	CA-10	CA-20	CA-40
Power Supply			
Standard Voltage:	DC: 13.2V	DC: 13.2V	DC: 13.2V
Usable Voltage:	DC: 10-18V	DC: 10-18V	DC: 10-18V
Power Consumption			
With No Signal:	Less than 0.15A	Less than 0.25A	Less than 0.35A
At Rated Output:	Less than 1.7A	Less than 3.1A	Less than 5.6A
At Max. Output:	Less than 2.1A	Less than 3.8A	Less than 6.8A
Output Power:	Rated 10W Max. 15W	Rated 20W Max. 30W	Rated 40W Max. 60W
Distortion:	Less than 5% at 1kHz, 10W output	Less than 5% at 1kHz, 20W output	Less than 5% at 1kHz, 40W output
Output Impedance:	40, 80	40, 80	40, 80
Inputs:	MIC, 600Ω, 3mV AUX, 10kΩ, 500mV	MIC1, 600Ω, 3mV MIC2, 600Ω, 3mV AUX, 10kΩ, 500mV	MIC1, 600Ω, 3mV MIC2, 600Ω, 3mV AUX, 10kΩ, 500mV
Frequency Response:	200Hz-10kHz, less than ±3dB	200Hz-10kHz, less than ±3dB	200Hz-10kHz, less than ±3dB
S/N Ratio:	Better than 60dB	Better than 60dB	Better than 60dB
Dimensions:	90(W) × 67(D) × 132(D)mm	134(W) × 67(D) × 167(D)mm	134(W) × 67(D) × 205(D)mm
Weight:	0.6kg	1.2kg	1.5kg
Standard Microphone:	DM-53 Omni-directional Mike with Talk Switch Impedance: 600Ω Sensitivity: -73dB, ±3dB	DM-521L Uni-directional Mike with Talk Switch Impedance: 600Ω Sensitivity: -73dB, ±3dB	DM-521L Uni-directional Mike with Talk Switch Impedance: 600Ω Sensitivity: -73dB, ±3dB



UNIVERSITY SOUND
ALTEC SOUND PRODUCTS DIVISION

Specifications and Instructions

Model UW-30 Diatran® Underwater Loudspeaker

Special Features

- All Internal Components Sealed in Plastic
- Bracket or Flush Mounting
- Plastic Construction
- Permanent Color Finish
- Chlorine and Corrosion Proof
- 2 Year Warranty

Description and Application

The UW-30 represents a departure in the design of underwater sound sources. Its unique design (pat. #3670299) utilizes the case's structural enclosure as the sound transducer. This development makes possible a speaker that has no metal parts exposed to the outside, thus, eliminating rust, corrosion or other causes of short life expectancy. The transducer principle and its strong construction allows the UW-30 to operate at much greater depths than any prior type of underwater loudspeaker design. The 12.7 ounce ceramic magnet and state-of-the-art voice coil construction assure full fidelity response with lowest possible distortion throughout its power range.

The University model UW-30 is an underwater speaker designed for permanent installation and completely submerged operation. All internal components are encapsulated with a "hot-melt" (Polyamide Copolymer) process. The outer case is of high impact A.B.S. (Acrylonitrile butadiene styrene) plastic. Ideal for installation in both fresh and salt water pools, the UW-30 can even be installed in ocean environments without adverse affect. Problems, such as, corrosion and electrolysis damage inherent in all or partial metal underwater speakers are completely eliminated by the plastic construction of the UW-30.

The model UW-30 may be flush mounted in a wet-niche, similar to that used for underwater lights (Paragon C-9120 or equivalent), or bracket mounted to the side of the pool. The University model PSB unit, bracket mounting kit, is available as an accessory item and contains all mounting hardware as well as a serrated swivel base. For pools where no provision has been made the PSB kit permits easy installation of the UW-30.

A single model UW-30 will deliver uniform sound throughout moderate size pools, up to 30 by 30 feet. For larger pools up to 30 by 60 feet, two speakers should be used. If a high level of turbulence is to be overcome, such as swimming and diving instruction classes, several speakers should be used. The noise level in the water will not only be more effectively overcome, but it will also allow each speaker to be operated at a lower power level thus avoiding excessive sound intensities in the immediate vicinity of the speakers.

Underwater speakers are required equipment for many activities in commercial and luxury resort pools. As specified by the American Athletic Union underwater speakers are required for synchronized swimming events and instructions in Olympic pools. They are used for water ballets and similar water shows. When underwater speakers are installed in resort and private pools, the effect of music played underwater is truly an enchanting experience.

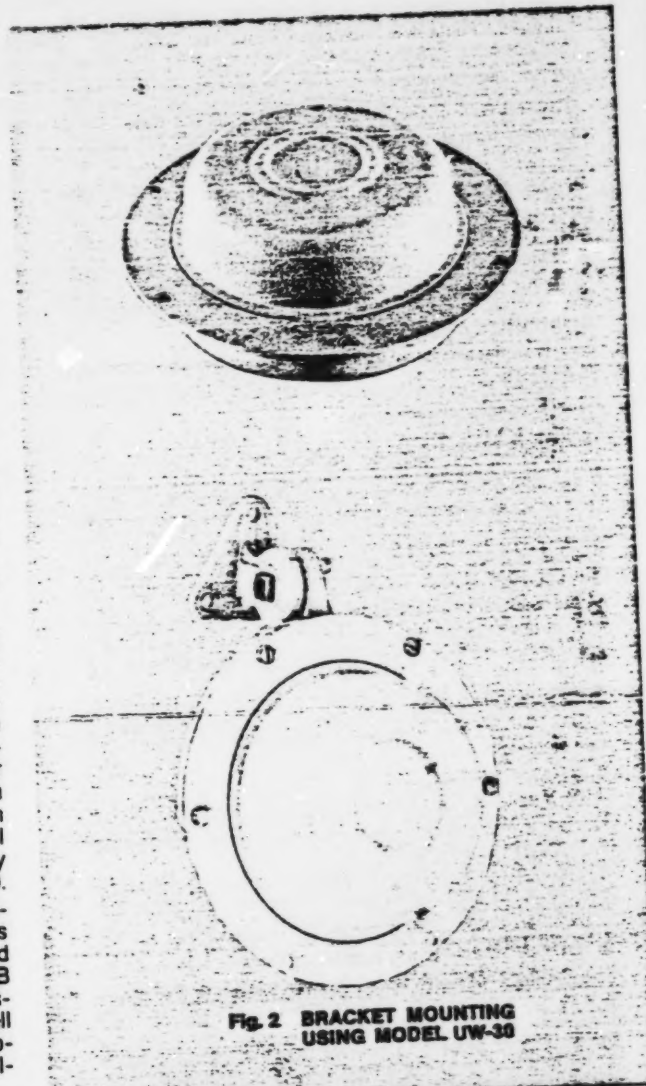


Fig. 2 BRACKET MOUNTING
USING MODEL UW-30

Specifications

Frequency Response:	100-10,000 cps
Power Handling Capacity:	30 watts IPM*
Impedance:	8 ohms
Dispersion:	Omni-Directional underwater
Operating Depth:	Up to 10 feet below surface of water
Recommended Installation Depth:	4 feet
Finish:	Pool Blue
Dimensions:	7 3/4" over-all diameter, 2 6 1/2" depth
Shipping Weight:	4 lbs.

*Integrated Program Material

Model UW-30 Diatran Underwater Loudspeaker

Architect and Engineers Specifications

Underwater speaker shall be University Sound model UW-30. Case shall be color impregnated, shatterproof A.B.S. plastic. Speakers shall not be subject to damage or corrosion from concentrations of chlorine, acid conditions, electrolysis, salt water or ocean environments and such minerals that may be in solution or suspension in such waters. Frequency response shall be 100-10kHz, and impedance shall be 8 ohms. Power handling capacity shall be 30 watts IPM (music power), and dispersion shall be omni-directional underwater. Operating depth shall be not more than 10 feet below the surface of the water. Recommended operating depth for optimum efficiency shall be not more than 4 feet. Speakers shall be equipped with a 50 foot, 3 conductor waterproof cable terminated within the internal encapsulation material. Case diameter shall be 7 $\frac{1}{2}$ inches, and depth shall be 2.61 inches. Six $\frac{1}{8}$ inch holes on a 6.684 inch circle shall be provided for mounting. Speaker may be mounted in a wet-niche or bracket mounted. Finish shall be pool blue. Shipping weight shall be 4 pounds. University Sound model UW-30 is specified.

Installing the Speaker

The University Model UW-30 may be installed in one of two different ways:

1. Flush mounted
2. Bracket mounted

Flush Mounting

For new pool construction and modification of older pools, installing the UW-30 flush with the sides of the pool makes a very neat and unobtrusive installation. The speaker is mounted in a wet-niche (Paragon C-9120 or equivalent) in the same manner as an underwater light. Figure 1 shows a typical installation. The speaker is mounted up to 4 feet below the surface of the water and flush with the side of the pool. (For installation in water depths lower than recommended please contact factory.) A marine plywood or stainless steel mounting ring is recommended. The wet-niche itself may be square or cylindrical in shape as desired. Several pool equipment manufacturers have wet-niches available into which the UW-30 may be installed. See your local pool supplier or University dealer for further information.

Bracket Mounting

By means of the University Model PSB Bracket Mounting Kit, the Model UW-30 may be bracket mounted to the side of the pool. See Figure 2.

The PSB kit includes all necessary mounting hardware as well as a serrated swivel base. Complete instructions for mounting the speaker are included in the PSB kit. For further information, see your local University dealer or write to our Customer Service Department.

Special Installation Recommendations

Fusing

For maximum protection against overload of the speaker, fusing the line from the amplifier is recommended. In the event of accidental overload, it is much easier to replace a fuse (which is above the water) than to replace or have the speaker repaired. University recommends installing a 25 ohm 20 watt resistor in parallel with a 1.5 ampere fast-blowing fuse in series with the speaker. See Figure 3.

University Sound Full Warranty

1. Altec Corporation warrants all University Sound Products to be free from defects in materials and workmanship for the following periods commencing from the date of purchase from an Authorized University Sound Distributor.

- | | |
|-----------------------------------|----------------|
| A. Speakers, Drivers, | Five (5) Years |
| Microphone Stands and Accessories | Two (2) Years |
| B. Underwater products | |

Altec, at its option, and at its expense, will replace defective parts or repair malfunctioning University Sound Products when the defect, malfunction, or failure is not caused by damage after delivery or by unreasonable use (including failure to provide reasonable and necessary maintenance).

Layout of Speakers in Pool

When underwater speakers are installed, particularly in smaller pools where only one or two speakers are needed, they should be located in the deep end of the pool. The above recommendation will effectively equalize the intensity of sound throughout the pool. For installations in large pools, such as at country clubs, municipal facilities, etc., the speakers should be located around the periphery of the pool. A good rule to follow for large pools is one speaker for every 900 square feet of pool surface at the deep end and one speaker for every 1200 square feet of pool surface for the shallow end. Of course, for high noise conditions in the pool, the number of speakers should be doubled for best results.

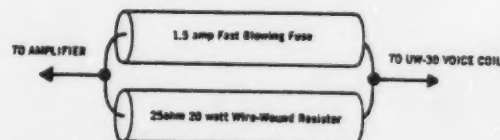
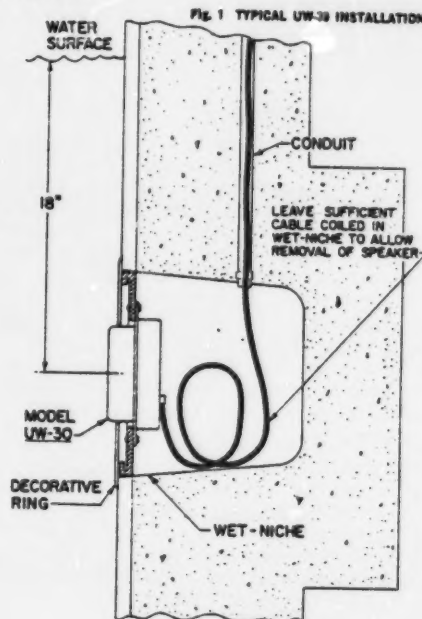
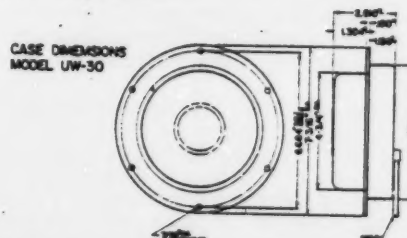


Fig. 3 FUSING CIRCUIT



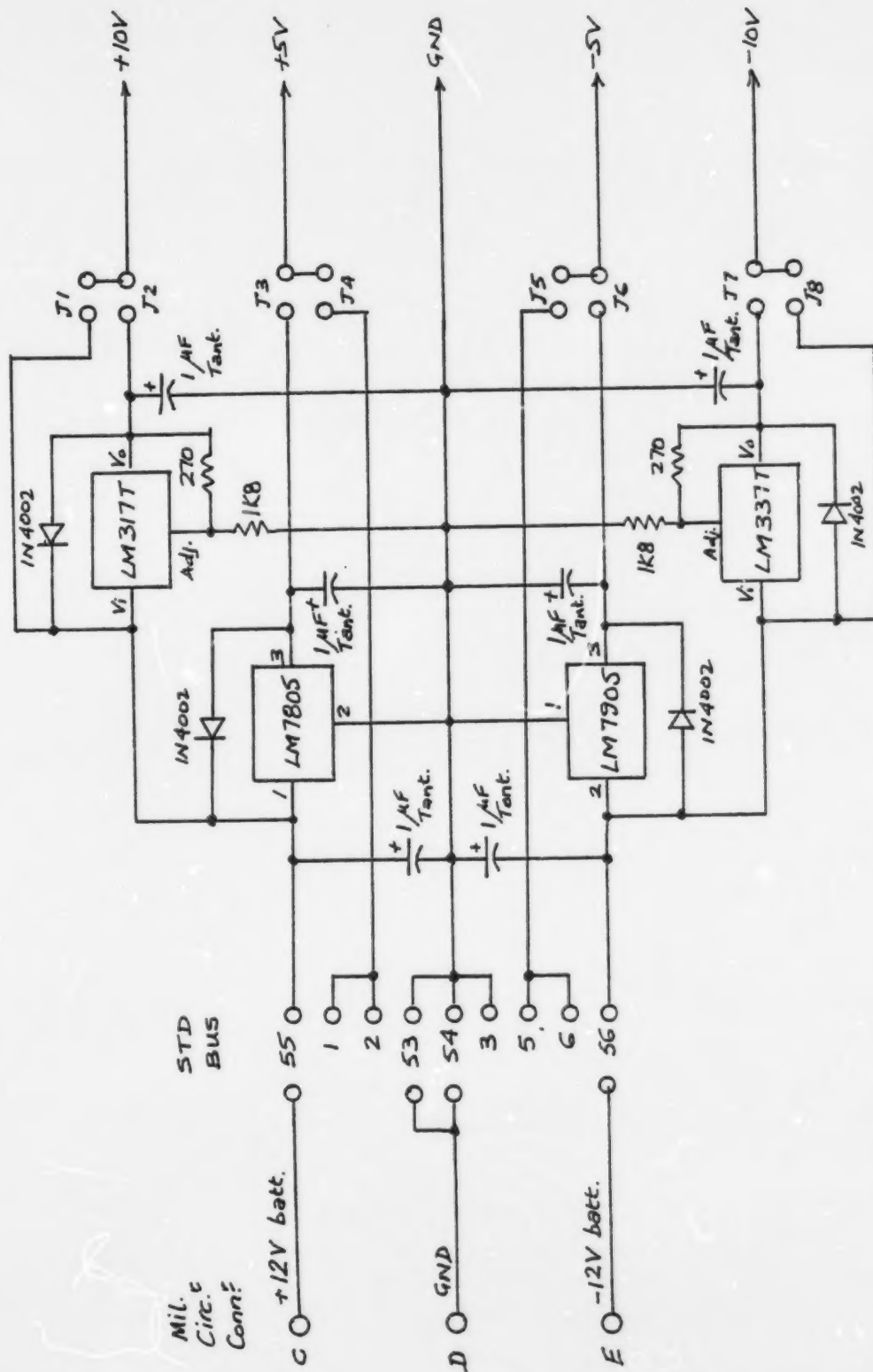
2. For warranty work, please return the University Sound Product via prepaid transportation to Altec Corporation, University Sound Repair Department, 10500 W. Reno, Oklahoma City, Oklahoma 73126. It is suggested that you keep the original sales contract as evidence of purchase.

3. This warranty is given in lieu of any other express warranty. This warranty does not cover consequential damages. Some states do not allow the exclusion of incidental or consequential damages, so the above exclusion may not apply to you.

4. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.



UNIVERSITY SOUND®
ALTEC SOUND PRODUCTS DIVISION
10500 West Reno • P.O. Box 26105
Oklahoma City, Oklahoma 73126



POLAR TECH LTD

ACE ICE PROFILER

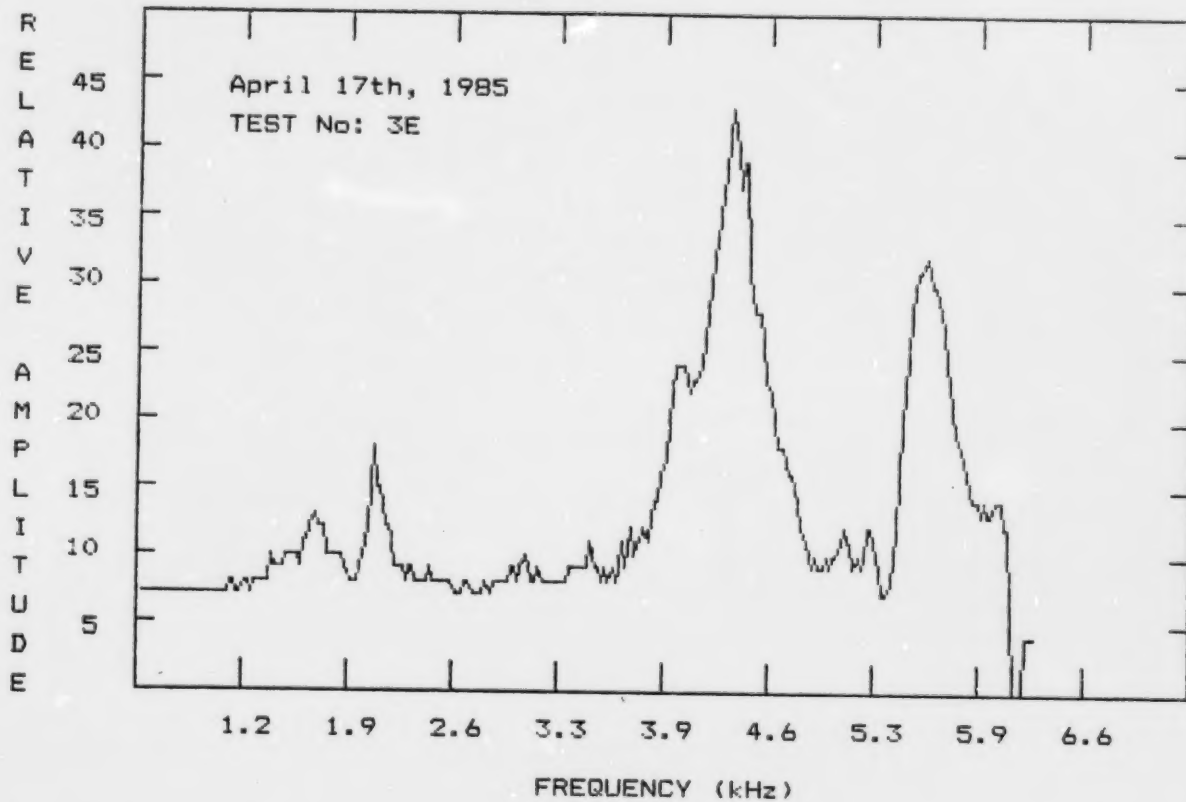
TX / RX : POWER SUPPLIES

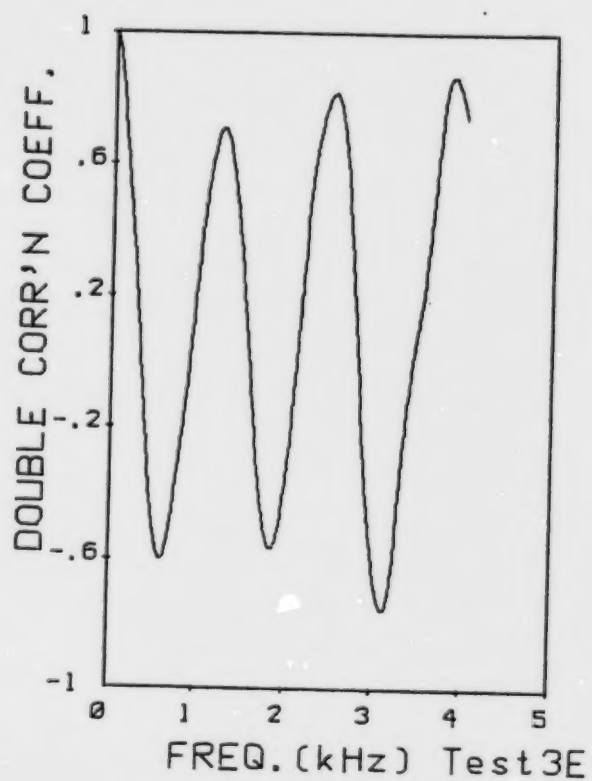
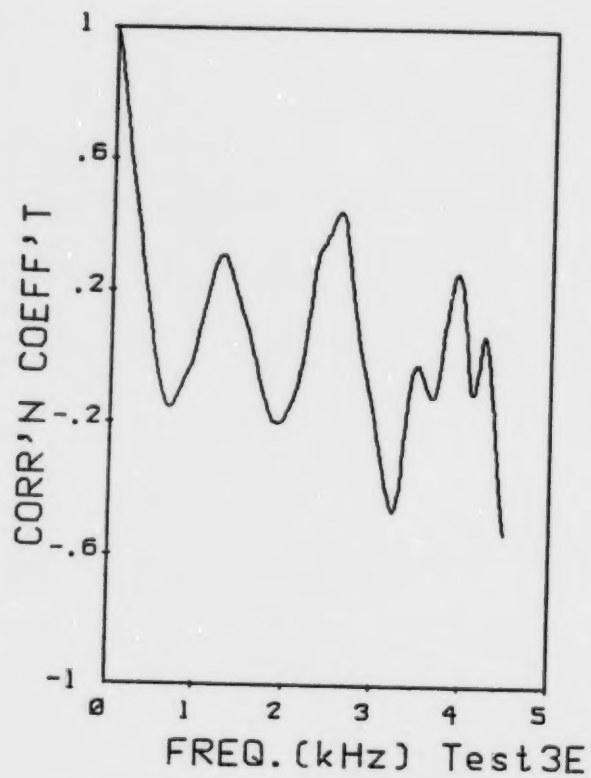
DWN: BJC/ADH CONTRACT: 115

DATE: FEB 85 REV NO: 1 DWG#5

APPENDIX III

Additional Field Data





Acoustic Signature Analysis

Source Data File: B:TEST3E

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4499.0000	0.0000	5000.0000	1000.0000	FREQ.(kHz) Test3E
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	CORR'N COEFF'T

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.982	22.3828	44.6771
2	0.953	44.7656	22.3386
3	0.916	67.1484	14.8924
4	0.871	89.5313	11.1693
5	0.820	111.9140	8.9354
6	0.767	134.2970	7.4462
7	0.715	156.6800	6.3824
8	0.664	179.0630	5.5846
9	0.614	201.4450	4.9641
10	0.565	223.8280	4.4677
11	0.520	246.2110	4.0616
12	0.474	268.5940	3.7231
13	0.429	290.9770	3.4367
14	0.387	313.3590	3.1912
15	0.346	335.7420	2.9785
16	0.304	358.1250	2.7923
17	0.262	380.5080	2.6281
18	0.219	402.8910	2.4821
19	0.175	425.2730	2.3514
20	0.132	447.6560	2.2339
21	0.088	470.0390	2.1275
22	0.047	492.4220	2.0308
23	0.008	514.8050	1.9425
24	-0.027	537.1880	1.8615
25	-0.060	559.5700	1.7871
26	-0.090	581.9530	1.7184
27	-0.115	604.3360	1.6547
28	-0.135	626.7190	1.5956
29	-0.151	649.1020	1.5406
30	-0.161	671.4840	1.4892

32	-0.160	716.2500	1.3962
33	-0.152	738.6330	1.3539
34	-0.141	761.0160	1.3140
35	-0.125	783.3980	1.2765
36	-0.108	805.7810	1.2410
37	-0.092	828.1640	1.2075
38	-0.078	850.5470	1.1757
39	-0.064	872.9300	1.1456
40	-0.052	895.3130	1.1169
41	-0.040	917.6950	1.0897
42	-0.025	940.0780	1.0637
43	-0.006	962.4610	1.0390
44	0.016	984.8440	1.0154
45	0.041	1007.2300	0.9928
46	0.069	1029.6100	0.9712
47	0.100	1051.9900	0.9506
48	0.132	1074.3800	0.9308
49	0.163	1096.7600	0.9118
50	0.194	1119.1400	0.8935
51	0.224	1141.5200	0.8760
52	0.251	1163.9100	0.8592
53	0.273	1186.2900	0.8430
54	0.292	1208.6700	0.8274
55	0.306	1231.0500	0.8123
56	0.311	1253.4400	0.7978
57	0.310	1275.8200	0.7838
58	0.305	1298.2000	0.7703
59	0.293	1320.5900	0.7572
60	0.276	1342.9700	0.7446
61	0.256	1365.3500	0.7324
62	0.236	1387.7300	0.7206
63	0.214	1410.1200	0.7092
64	0.190	1432.5000	0.6981
65	0.168	1454.8800	0.6873
66	0.150	1477.2700	0.6769
67	0.132	1499.6500	0.6668
68	0.114	1522.0300	0.6570
69	0.094	1544.4100	0.6475
70	0.074	1566.8000	0.6382
71	0.051	1589.1800	0.6293
72	0.028	1611.5600	0.6205
73	0.004	1633.9500	0.6120
74	-0.021	1656.3300	0.6037
75	-0.045	1678.7100	0.5957
76	-0.073	1701.0900	0.5879
77	-0.100	1723.4800	0.5802
78	-0.124	1745.8600	0.5728
79	-0.144	1768.2400	0.5655
80	-0.166	1790.6300	0.5585
81	-0.185	1813.0100	0.5516
82	-0.199	1835.3900	0.5448
83	-0.206	1857.7700	0.5383
84	-0.208	1880.1600	0.5319
85	-0.209	1902.5400	0.5256
86	-0.207	1924.9200	0.5195
87	-0.203	1947.3000	0.5135
88	-0.197	1969.6900	0.5077
89	-0.188	1992.0700	0.5020
90	-0.175	2014.4500	0.4964
91	-0.162	2036.8400	0.4910
92	-0.147	2059.2200	0.4856
93	-0.130	2081.6000	0.4804
94	-0.111	2103.9800	0.4753
95	-0.089	2126.3700	0.4703
96	-0.072	2148.7500	0.4654

97	-0.047	2171.1300	0.4606
98	-0.015	2193.5200	0.4559
99	0.022	2215.9000	0.4513
100	0.063	2238.2800	0.4468
101	0.112	2260.6600	0.4423
102	0.163	2283.0500	0.4380
103	0.212	2305.4300	0.4338
104	0.263	2327.8100	0.4296
105	0.300	2350.2000	0.4255
106	0.326	2372.5800	0.4215
107	0.335	2394.9600	0.4175
108	0.343	2417.3400	0.4137
109	0.354	2439.7300	0.4099
110	0.378	2462.1100	0.4062
111	0.381	2484.4900	0.4025
112	0.397	2506.8800	0.3989
113	0.417	2529.2600	0.3954
114	0.426	2551.6400	0.3919
115	0.436	2574.0200	0.3885
116	0.448	2596.4100	0.3851
117	0.436	2618.7900	0.3819
118	0.425	2641.1700	0.3786
119	0.396	2663.5500	0.3754
120	0.348	2685.9400	0.3723
121	0.302	2708.3200	0.3692
122	0.247	2730.7000	0.3662
123	0.195	2753.0900	0.3632
124	0.144	2775.4700	0.3603
125	0.102	2797.8500	0.3574
126	0.060	2820.2300	0.3546
127	0.036	2842.6200	0.3518
128	0.004	2865.0000	0.3490
129	-0.027	2887.3800	0.3463
130	-0.053	2909.7700	0.3437
131	-0.081	2932.1500	0.3410
132	-0.114	2954.5300	0.3385
133	-0.141	2976.9100	0.3359
134	-0.166	2999.3000	0.3334
135	-0.207	3021.6800	0.3309
136	-0.247	3044.0600	0.3285
137	-0.287	3066.4500	0.3261
138	-0.320	3088.8300	0.3237
139	-0.355	3111.2100	0.3214
140	-0.388	3133.5900	0.3191
141	-0.409	3155.9800	0.3169
142	-0.422	3178.3600	0.3146
143	-0.448	3200.7400	0.3124
144	-0.471	3223.1300	0.3103
145	-0.474	3245.5100	0.3081
146	-0.453	3267.8900	0.3060
147	-0.427	3290.2700	0.3039
148	-0.391	3312.6600	0.3019
149	-0.329	3335.0400	0.2998
150	-0.258	3357.4200	0.2978
151	-0.192	3379.8000	0.2959
152	-0.130	3402.1900	0.2939
153	-0.082	3424.5700	0.2920
154	-0.047	3446.9500	0.2901
155	-0.029	3469.3400	0.2882
156	-0.026	3491.7200	0.2864
157	-0.020	3514.1000	0.2846
158	-0.028	3536.4800	0.2828
159	-0.044	3558.8700	0.2810
160	-0.063	3581.2500	0.2792
161	-0.087	3603.6300	0.2775
162	-0.102	3626.0200	0.2758

163	-0.114	3648.4000	0.2741
164	-0.122	3670.7800	0.2724
165	-0.118	3693.1600	0.2708
166	-0.109	3715.5500	0.2691
167	-0.077	3737.9300	0.2675
168	-0.041	3760.3100	0.2659
169	0.004	3782.7000	0.2644
170	0.057	3805.0800	0.2628
171	0.095	3827.4600	0.2613
172	0.130	3849.8400	0.2598
173	0.180	3872.2300	0.2582
174	0.223	3894.6100	0.2568
175	0.250	3916.9900	0.2553
176	<u>0.264</u>	<u>3939.3800</u>	0.2538
177	0.259	3961.7600	0.2524
178	0.243	3984.1400	0.2510
179	0.214	4006.5200	0.2496
180	0.135	4028.9100	0.2482
181	0.070	4051.2900	0.2468
182	-0.023	4073.6700	0.2455
183	-0.095	4096.0500	0.2441
184	-0.116	4118.4400	0.2428
185	-0.115	4140.8200	0.2415
186	-0.096	4163.2000	0.2402
187	-0.055	4185.5900	0.2389
188	-0.019	4207.9700	0.2376
189	0.046	4230.3500	0.2364
190	0.073	4252.7300	0.2351
191	0.053	4275.1200	0.2339
192	0.008	4297.5000	0.2327
193	-0.046	4319.8800	0.2315
194	-0.108	4342.2700	0.2303
195	-0.174	4364.6500	0.2291
196	-0.260	4387.0300	0.2279
197	-0.332	4409.4100	0.2268
198	-0.396	4431.8000	0.2256
199	-0.470	4454.1800	0.2245
200	-0.518	4476.5600	0.2234
201	-0.538	4498.9500	0.2223

1265
2600
3940

Acoustic Signature Analysis

Source Data File: B:TEST3E Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	0.0000	5000.0000	1000.0000	FREQ. (kHz) Test3E
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	DOUBLE CORR'N COEFF.

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.993	22.2736	44.8961
2	0.971	44.5473	22.4481
3	0.935	66.8209	14.9654
4	0.885	89.0945	11.2240
5	0.825	111.3680	8.9792
6	0.757	133.6420	7.4827
7	0.685	155.9150	6.4137
8	0.610	178.1890	5.6120
9	0.535	200.4630	4.9885
10	0.461	222.7360	4.4896
11	0.388	245.0100	4.0815
12	0.316	267.2840	3.7413
13	0.242	289.5570	3.4535
14	0.164	311.8310	3.2069
15	0.083	334.1050	2.9931
16	-0.001	356.3780	2.8060
17	-0.086	378.6520	2.6409
18	-0.172	400.9250	2.4942
19	-0.255	423.1990	2.3630
20	-0.333	445.4730	2.2448
21	-0.401	467.7460	2.1379
22	-0.461	490.0200	2.0407
23	-0.511	512.2940	1.9520
24	-0.551	534.5670	1.8707
25	-0.582	556.8410	1.7958
26	-0.601	579.1140	1.7268
27	-0.610	601.3880	1.6628
28	-0.608	623.6620	1.6034
29	-0.595	645.9350	1.5481
30	-0.573	668.2090	1.4965

31	-0.542	690.4830	1.4483
32	-0.503	712.7560	1.4030
33	-0.457	735.0300	1.3605
34	-0.407	757.3030	1.3205
35	-0.354	779.5770	1.2827
36	-0.299	801.8510	1.2471
37	-0.243	824.1240	1.2134
38	-0.185	846.3980	1.1815
39	-0.125	868.6720	1.1512
40	-0.064	890.9450	1.1224
41	-0.002	913.2190	1.0950
42	0.063	935.4930	1.0690
43	0.129	957.7660	1.0441
44	0.196	980.0400	1.0204
45	0.263	1002.3100	0.9977
46	0.328	1024.5900	0.9760
47	0.393	1046.8600	0.9552
48	0.454	1069.1300	0.9353
49	0.510	1091.4100	0.9162
50	0.561	1113.6800	0.8979
51	0.605	1135.9600	0.8803
52	0.642	1158.2300	0.8634
53	0.671	1180.5000	0.8471
54	0.692	1202.7800	0.8314
55	0.705	1225.0500	0.8163
56	0.710	1247.3200	0.8017
57	0.707	1269.6000	0.7877
58	0.696	1291.8700	0.7741
59	0.676	1314.1400	0.7610
60	0.648	1336.4200	0.7483
61	0.612	1358.6900	0.7360
62	0.567	1380.9700	0.7241
63	0.516	1403.2400	0.7126
64	0.459	1425.5100	0.7015
65	0.397	1447.7900	0.6907
66	0.331	1470.0600	0.6802
67	0.263	1492.3300	0.6701
68	0.193	1514.6100	0.6602
69	0.120	1536.8800	0.6507
70	0.047	1559.1500	0.6414
71	-0.026	1581.4300	0.6323
72	-0.099	1603.7000	0.6236
73	-0.171	1625.9800	0.6150
74	-0.241	1648.2500	0.6067
75	-0.308	1670.5200	0.5986
76	-0.371	1692.8000	0.5907
77	-0.427	1715.0700	0.5831
78	-0.476	1737.3400	0.5756
79	-0.516	1759.6200	0.5683
80	-0.546	1781.8900	0.5612
81	-0.566	1804.1600	0.5543
82	-0.577	1826.4400	0.5475
83	-0.577	1848.7100	0.5409
84	-0.569	1870.9900	0.5345
85	-0.553	1893.2600	0.5282
86	-0.530	1915.5300	0.5220
87	-0.500	1937.8100	0.5160
88	-0.462	1960.0800	0.5102
89	-0.418	1982.3500	0.5045
90	-0.366	2004.6300	0.4988
91	-0.308	2026.9000	0.4934
92	-0.242	2049.1700	0.4880
93	-0.171	2071.4500	0.4828
94	-0.093	2093.7200	0.4776
95	-0.010	2116.0000	0.4726
96	0.077	2138.2700	0.4677

97	0.1		
98	0.254	2182.8200	0.4581
99	0.337	2205.0900	0.4535
100	0.414	2227.3600	0.4490
101	0.482	2249.6400	0.4445
102	0.542	2271.9100	0.4402
103	0.594	2294.1800	0.4359
104	0.638	2316.4600	0.4317
105	0.675	2338.7300	0.4276
106	0.707	2361.0000	0.4235
107	0.736	2383.2800	0.4196
108	0.761	2405.5500	0.4157
109	0.783	2427.8300	0.4119
110	0.800	2450.1000	0.4081
111	0.813	2472.3700	0.4045
112	0.820	2494.6500	0.4009
113	0.821	2516.9200	0.3973
114	0.815	2539.1900	0.3938
115	0.801	2561.4700	0.3904
116	0.777	2583.7400	0.3870
117	0.743	2606.0100	0.3837
118	0.697	2628.2900	0.3805
119	0.639	2650.5600	0.3773
120	0.570	2672.8400	0.3741
121	0.491	2695.1100	0.3710
122	0.405	2717.3800	0.3680
123	0.313	2739.6600	0.3650
124	0.219	2761.9300	0.3621
125	0.124	2784.2000	0.3592
126	0.030	2806.4800	0.3563
127	-0.064	2828.7500	0.3535
128	-0.154	2851.0300	0.3508
129	-0.239	2873.3000	0.3480
130	-0.320	2895.5700	0.3454
131	-0.395	2917.8500	0.3427
132	-0.464	2940.1200	0.3401
133	-0.526	2962.3900	0.3376
134	-0.584	2984.6700	0.3350
135	-0.633	3006.9400	0.3326
136	-0.675	3029.2100	0.3301
137	-0.709	3051.4900	0.3277
138	-0.736	3073.7600	0.3253
139	-0.755	3096.0400	0.3230
140	-0.765	3118.3100	0.3207
141	-0.766	3140.5800	0.3184
142	-0.759	3162.8600	0.3162
143	-0.739	3185.1300	0.3140
144	-0.706	3207.4000	0.3118
145	-0.659	3229.6800	0.3096
146	-0.600	3251.9500	0.3075
147	-0.527	3274.2200	0.3054
148	-0.444	3296.5000	0.3034
149	-0.357	3318.7700	0.3013
150	-0.273	3341.0500	0.2993
151	-0.197	3363.3200	0.2973
152	-0.132	3385.5900	0.2954
153	-0.077	3407.8700	0.2934
154	-0.031	3430.1400	0.2915
155	0.009	3452.4100	0.2897
156	0.047	3474.6900	0.2878
157	0.082	3496.9600	0.2860
158	0.118	3519.2300	0.2842
159	0.159	3541.5100	0.2824
160	0.205	3563.7800	0.2806
161	0.259	3586.0500	0.2789
162	0.321	3608.3300	0.2771

163	0.389	3630.6000	0.2754
164	0.462	3652.8800	0.2738
165	0.538	3675.1500	0.2721
166	0.613	3697.4200	0.2705
167	0.681	3719.7000	0.2688
168	0.740	3741.9700	0.2672
169	0.788	3764.2400	0.2657
170	0.824	3786.5200	0.2641
171	0.850	3808.7900	0.2626
172	0.867	3831.0700	0.2610
173	0.874	<u>3853.3400</u>	0.2595
174	0.872	<u>3875.6100</u>	0.2580
175	0.863	3897.8900	0.2565
176	0.848	3920.1600	0.2551
177	0.827	3942.4300	0.2537
178	0.801	3964.7100	0.2522
179	0.772	3986.9800	0.2508
180	0.746	4009.2500	0.2494

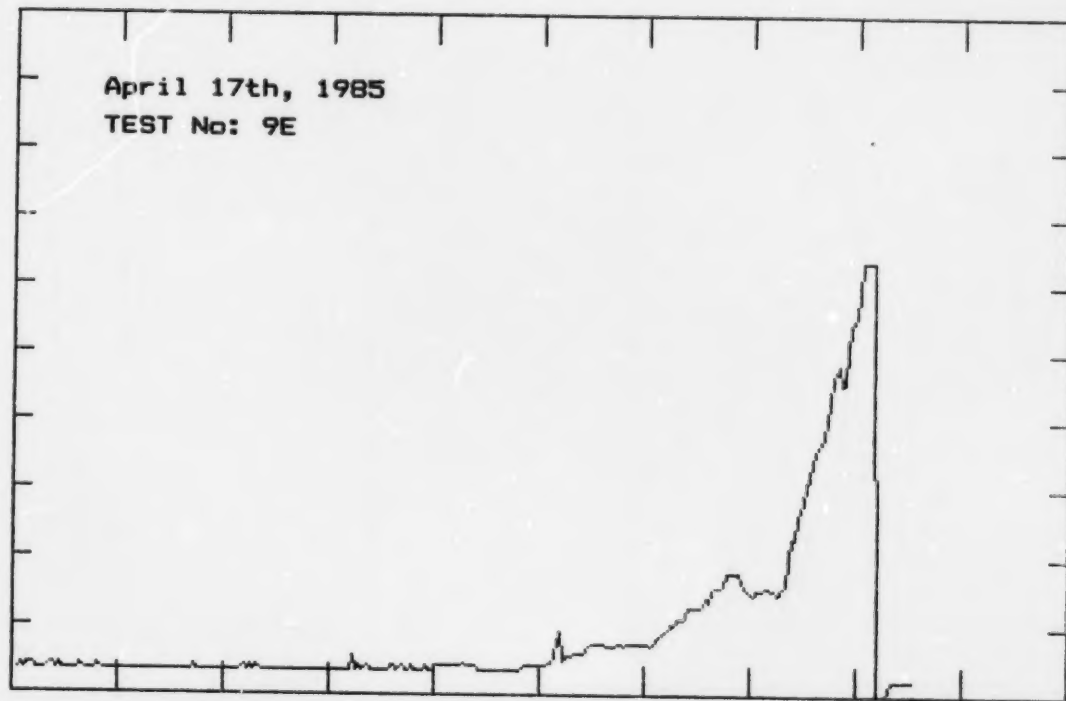
1250
2500
3760

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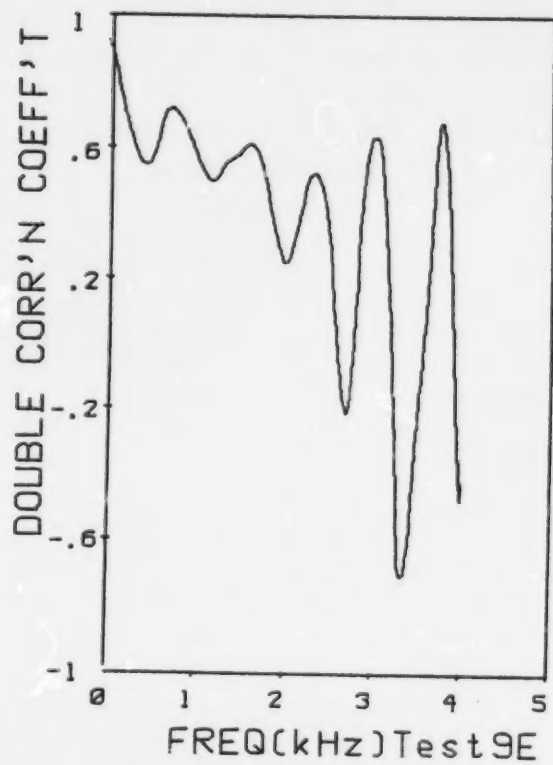
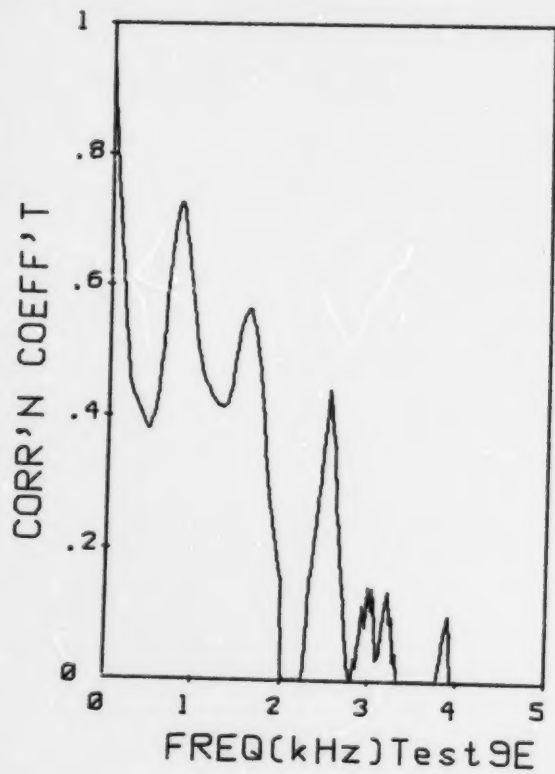
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180
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April 17th, 1985
TEST No: 9E



1.2 1.9 2.6 3.3 3.9 4.6 5.3 5.9 6.6
FREQUENCY (kHz)



Acoustic Signature Analysis

Source Data File: B:TEST9E

Data Description Parameters

Min	Max	Axis Min	Axis Max	Axis Seg	Label
22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.946	22.3828	44.6771
2	0.889	44.7656	22.3386
3	0.831	67.1484	14.8924
4	0.771	89.5313	11.1693
5	0.718	111.9140	8.9354
6	0.670	134.2970	7.4462
7	0.623	156.6800	6.3824
8	0.579	179.0630	5.5846
9	0.541	201.4450	4.9641
10	0.502	223.8280	4.4677
11	0.457	246.2110	4.0616
12	0.441	268.5940	3.7231
13	0.430	290.9770	3.4367
14	0.423	313.3590	3.1912
15	0.420	335.7420	2.9785
16	0.414	358.1250	2.7923
17	0.408	380.5080	2.6281
18	0.401	402.8910	2.4821
19	0.393	425.2730	2.3514
20	0.383	447.6560	2.2339
21	0.377	470.0390	2.1275
22	0.380	492.4220	2.0308
23	0.392	514.8050	1.9425
24	0.402	537.1880	1.8615
25	0.416	559.5700	1.7871
26	0.443	581.9530	1.7184
27	0.476	604.3360	1.6547
28	0.511	626.7190	1.5956
29	0.547	649.1020	1.5406
30	0.581	671.4840	1.4892

31	0.615	693.8670	1.4412
32	0.647	716.2500	1.3962
33	0.676	738.6330	1.3539
34	0.696	761.0160	1.3140
35	0.719	783.3980	1.2765
36	0.731	<u>805</u> .7810	1.2410
37	0.727	828.1640	1.2075
38	0.711	850.5470	1.1757
39	0.684	872.9300	1.1456
40	0.658	895.3130	1.1169
41	0.629	917.6950	1.0897
42	0.599	940.0780	1.0637
43	0.574	962.4610	1.0390
44	0.552	984.8440	1.0154
45	0.528	1007.2300	0.9928
46	0.503	1029.6100	0.9712
47	0.488	1051.9900	0.9506
48	0.470	1074.3800	0.9308
49	0.455	1096.7600	0.9118
50	0.450	1119.1400	0.8935
51	0.444	1141.5200	0.8760
52	0.437	1163.9100	0.8592
53	0.429	1186.2900	0.8430
54	0.423	1208.6700	0.8274
55	0.419	1231.0500	0.8123
56	0.414	1253.4400	0.7978
57	0.417	1275.8200	0.7838
58	0.411	1298.2000	0.7703
59	0.414	1320.5900	0.7572
60	0.417	1342.9700	0.7446
61	0.423	1365.3500	0.7324
62	0.434	1387.7300	0.7206
63	0.454	1410.1200	0.7092
64	0.485	1432.5000	0.6981
65	0.506	1454.8800	0.6873
66	0.525	1477.2700	0.6769
67	0.540	1499.6500	0.6668
68	0.550	1522.0300	0.6570
69	0.560	1544.4100	0.6475
70	0.563	1566.8000	0.6382
71	0.569	1589.1800	0.6293
72	0.563	<u>1611</u> .5600	0.6205
73	0.547	1633.9500	0.6120
74	0.536	1656.3300	0.6037
75	0.516	1678.7100	0.5957
76	0.499	1701.0900	0.5879
77	0.470	1723.4800	0.5802
78	0.436	1745.8600	0.5728
79	0.397	1768.2400	0.5655
80	0.346	1790.6300	0.5585
81	0.306	1813.0100	0.5516
82	0.277	1835.3900	0.5448
83	0.264	1857.7700	0.5383
84	0.243	1880.1600	0.5319
85	0.218	1902.5400	0.5256
86	0.207	1924.9200	0.5195
87	0.183	1947.3000	0.5135
88	0.161	1969.6900	0.5077
89	0.151	1992.0700	0.5020
90	0.007	2014.4500	0.4964
91	-0.050	2036.8400	0.4910
92	-0.058	2059.2200	0.4856
93	-0.071	2081.6000	0.4804
94	-0.062	2103.9800	0.4753
95	-0.056	2126.3700	0.4703
96	-0.051	2148.7500	0.4654

97	-0.052	2171.1300	0.4606
98	-0.053	2193.5200	0.4559
99	-0.054	2215.9000	0.4513
100	-0.057	2238.2800	0.4468
101	0.001	2260.6600	0.4423
102	0.060	2283.0500	0.4380
103	0.111	2305.4300	0.4338
104	0.156	2327.8100	0.4296
105	0.179	2350.2000	0.4255
106	0.212	2372.5800	0.4215
107	0.245	2394.9600	0.4175
108	0.277	2417.3400	0.4137
109	0.311	2439.7300	0.4099
110	0.354	2462.1100	0.4062
111	0.391	2484.4900	0.4025
112	0.417	2506.8800	0.3989
113	0.447	2529.2600	0.3954
114	0.412	2551.6400	0.3919
115	0.382	2574.0200	0.3885
116	0.352	2596.4100	0.3851
117	0.264	2618.7900	0.3819
118	0.228	2641.1700	0.3786
119	0.187	2663.5500	0.3754
120	0.154	2685.9400	0.3723
121	0.116	2708.3200	0.3692
122	0.070	2730.7000	0.3662
123	0.032	2753.0900	0.3632
124	0.007	2775.4700	0.3603
125	-0.018	2797.8500	0.3574
126	0.004	2820.2300	0.3546
127	0.038	2842.6200	0.3518
128	0.019	2865.0000	0.3490
129	0.052	2887.3800	0.3463
130	0.083	2909.7700	0.3437
131	0.120	2932.1500	0.3410
132	0.083	2954.5300	0.3385
133	0.118	2976.9100	0.3359
134	0.146	2999.3000	0.3334
135	0.108	3021.6800	0.3309
136	0.144	3044.0600	0.3285
137	0.088	3066.4500	0.3261
138	0.033	3088.8300	0.3237
139	0.041	3111.2100	0.3214
140	0.051	3133.5900	0.3191
141	0.079	3155.9800	0.3169
142	0.100	3178.3600	0.3146
143	0.122	3200.7400	0.3124
144	0.141	3223.1300	0.3103
145	0.089	3245.5100	0.3081
146	0.101	3267.8900	0.3060
147	0.030	3290.2700	0.3039
148	0.046	3312.6600	0.3019
149	-0.223	3335.0400	0.2998
150	-0.220	3357.4200	0.2978
151	-0.216	3379.8000	0.2959
152	-0.215	3402.1900	0.2939
153	-0.198	3424.5700	0.2920
154	-0.197	3446.9500	0.2901
155	-0.192	3469.3400	0.2882
156	-0.168	3491.7200	0.2864
157	-0.169	3514.1000	0.2846
158	-0.145	3536.4800	0.2828
159	-0.141	3558.8700	0.2810
160	-0.085	3581.2500	0.2792
161	-0.079	3603.6300	0.2775
162	-0.067	3626.0200	0.2758

163	-0.059	3648.4000	0.2741
164	-0.048	3670.7800	0.2724
165	-0.039	3693.1600	0.2708
166	-0.036	3715.5500	0.2691
167	-0.026	3737.9300	0.2675
168	-0.014	3760.3100	0.2659
169	0.002	3782.7000	0.2644
170	0.013	3805.0800	0.2628
171	0.027	3827.4600	0.2613
172	0.056	3849.8400	0.2598
173	0.077	3872.2300	0.2582
174	0.093	3894.6100	0.2568
175	0.105	3916.9900	0.2553
176	-0.010	3939.3800	0.2538
177	-0.009	3961.7600	0.2524
178	-0.131	3984.1400	0.2510
179	-0.127	4006.5200	0.2496
180	-0.246	4028.9100	0.2482
181	-0.239	4051.2900	0.2468
182	-0.228	4073.6700	0.2455
183	-0.228	4096.0500	0.2441
184	-0.231	4118.4400	0.2428
185	-0.232	4140.8200	0.2415
186	-0.222	4163.2000	0.2402
187	-0.175	4185.5900	0.2389
188	-0.175	4207.9700	0.2376
189	-0.127	4230.3500	0.2364
190	-0.114	4252.7300	0.2351
191	-0.071	4275.1200	0.2339
192	-0.065	4297.5000	0.2327
193	-0.067	4319.8800	0.2315
194	-0.225	4342.2700	0.2303
195	-0.223	4364.6500	0.2291
196	-0.223	4387.0300	0.2279
197	-0.223	4409.4100	0.2268
198	-0.220	4431.8000	0.2256
199	-0.215	4454.1800	0.2245
200	-0.210	4476.5600	0.2234
201	-0.192	4498.9500	0.2223

810, 1590, 2530, (3000), (3040), 3910
797.0

$c = 2789 \text{ m/s}$
 $d = 1.75 \mu$
 $n = 2$

Acoustic Signature Analysis

Source Data File: B:TEST9E

Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.991	22.2736	44.8961
2	0.977	44.5473	22.4481
3	0.955	66.8209	14.9654
4	0.929	89.0945	11.2240
5	0.899	111.3680	8.9792
6	0.868	133.6420	7.4827
7	0.836	155.9150	6.4137
8	0.804	178.1890	5.6120
9	0.774	200.4630	4.9885
10	0.747	222.7360	4.4896
11	0.720	245.0100	4.0815
12	0.698	267.2840	3.7413
13	0.676	289.5570	3.4535
14	0.659	311.8310	3.2069
15	0.642	334.1050	2.9931
16	0.629	356.3780	2.8060
17	0.619	378.6520	2.6409
18	0.610	400.9250	2.4942
19	0.605	423.1990	2.3630
20	0.605	445.4730	2.2448
21	0.609	467.7460	2.1379
22	0.617	490.0200	2.0407
23	0.631	512.2940	1.9520
24	0.648	534.5670	1.8707
25	0.669	556.8410	1.7958
26	0.691	579.1140	1.7268
27	0.716	601.3880	1.6628
28	0.736	623.6620	1.6034
29	0.755	645.9350	1.5481
30	0.768	668.2090	1.4965

31	0.779	690.4830	1
32	0.783	712.7560	1.4030
33	0.784	735.0300	1.3605
34	0.780	757.3030	1.3205
35	0.774	779.5770	1.2827
36	0.765	801.8510	1.2471
37	0.755	824.1240	1.2134
38	0.744	846.3980	1.1815
39	0.732	868.6720	1.1512
40	0.719	890.9450	1.1224
41	0.705	913.2190	1.0950
42	0.690	935.4930	1.0690
43	0.675	957.7660	1.0441
44	0.660	980.0400	1.0204
45	0.645	1002.3100	0.9977
46	0.627	1024.5900	0.9760
47	0.612	1046.8600	0.9552
48	0.596	1069.1300	0.9353
49	0.582	1091.4100	0.9162
50	0.569	1113.6800	0.8979
51	0.559	1135.9600	0.8803
52	0.552	1158.2300	0.8634
53	0.551	1180.5000	0.8471
54	0.555	1202.7800	0.8314
55	0.563	1225.0500	0.8163
56	0.574	1247.3200	0.8017
57	0.585	1269.6000	0.7877
58	0.597	1291.8700	0.7741
59	0.608	1314.1400	0.7610
60	0.613	1336.4200	0.7483
61	0.618	1358.6900	0.7360
62	0.623	1380.9700	0.7241
63	0.626	1403.2400	0.7126
64	0.629	1425.5100	0.7015
65	0.633	1447.7900	0.6907
66	0.639	1470.0600	0.6802
67	0.645	1492.3300	0.6701
68	0.652	1514.6100	0.6602
69	0.659	1536.8800	0.6507
70	0.663	1559.1500	0.6414
71	0.667	1581.4300	0.6323
72	0.667	1603.7000	0.6236
73	0.665	1625.9800	0.6150
74	0.659	1648.2500	0.6067
75	0.651	1670.5200	0.5986
76	0.639	1692.8000	0.5907
77	0.622	1715.0700	0.5831
78	0.599	1737.3400	0.5756
79	0.570	1759.6200	0.5683
80	0.539	1781.8900	0.5612
81	0.503	1804.1600	0.5543
82	0.468	1826.4400	0.5475
83	0.434	1848.7100	0.5409
84	0.403	1870.9900	0.5345
85	0.377	1893.2600	0.5282
86	0.356	1915.5300	0.5220
87	0.335	1937.8100	0.5160
88	0.319	1960.0800	0.5102
89	0.303	1982.3500	0.5045
90	0.303	2004.6300	0.4988
91	0.312	2026.9000	0.4934
92	0.326	2049.1700	0.4880
93	0.346	2071.4500	0.4828
94	0.369	2093.7200	0.4776
95	0.392	2116.0000	0.4726
96	0.415	2138.2700	0.4677

97	0.438	2160.5400	0.4628
98	0.463	2182.8200	0.4581
99	0.489	2205.0900	0.4535
100	0.518	2227.3600	0.4490
101	0.540	2249.6400	0.4445
102	0.558	2271.9100	0.4402
103	0.572	2294.1800	0.4359
104	0.579	<u>2316.4600</u>	0.4317
105	0.578	<u>2338.7300</u>	0.4276
106	0.574	2361.0000	0.4235
107	0.565	2383.2800	0.4196
108	0.551	2405.5500	0.4157
109	0.530	2427.8300	0.4119
110	0.502	2450.1000	0.4081
111	0.462	2472.3700	0.4045
112	0.410	2494.6500	0.4009
113	0.341	2516.9200	0.3973
114	0.263	2539.1900	0.3938
115	0.179	2561.4700	0.3904
116	0.088	2583.7400	0.3870
117	0.013	2606.0100	0.3837
118	-0.054	2628.2900	0.3805
119	-0.108	2650.5600	0.3773
120	-0.145	2672.8400	0.3741
121	-0.159	2695.1100	0.3710
122	-0.143	2717.3800	0.3680
123	-0.096	2739.6600	0.3650
124	-0.025	2761.9300	0.3621
125	0.065	2784.2000	0.3592
126	0.156	2806.4800	0.3563
127	0.239	2828.7500	0.3535
128	0.330	2851.0300	0.3508
129	0.410	2873.3000	0.3480
130	0.479	2895.5700	0.3454
131	0.534	2917.8500	0.3427
132	0.596	2940.1200	0.3401
133	0.640	2962.3900	0.3376
134	0.668	2984.6700	0.3350
135	0.692	<u>3006.9400</u>	0.3326
136	0.693	<u>3029.2100</u>	0.3301
137	0.690	3051.4900	0.3277
138	0.688	3073.7600	0.3253
139	0.660	3096.0400	0.3230
140	0.609	3118.3100	0.3207
141	0.530	3140.5800	0.3184
142	0.424	3162.8600	0.3162
143	0.287	3185.1300	0.3140
144	0.118	3207.4000	0.3118
145	-0.051	3229.6800	0.3096
146	-0.250	3251.9500	0.3075
147	-0.425	3274.2200	0.3054
148	-0.620	3296.5000	0.3034
149	-0.647	3318.7700	0.3013
150	-0.651	3341.0500	0.2993
151	-0.633	3363.3200	0.2973
152	-0.595	3385.5900	0.2954
153	-0.545	3407.8700	0.2934
154	-0.480	3430.1400	0.2915
155	-0.403	3452.4100	0.2897
156	-0.331	3474.6900	0.2878
157	-0.252	3496.9600	0.2860
158	-0.178	3519.2300	0.2842
159	-0.098	3541.5100	0.2824
160	-0.043	3563.7800	0.2806
161	0.015	3586.0500	0.2789
162	0.077	3608.3300	0.2771

163	0.148	3630.6000	0.2754
164	0.226	3652.8800	0.2738
165	0.313	3675.1500	0.2721
166	0.408	3697.4200	0.2705
167	0.504	3719.7000	0.2688
168	0.592	3741.9700	0.2672
169	0.666	3764.2400	0.2657
170	0.719	3786.5200	0.2641
171	0.744	3808.7900	0.2626
172	0.734	3831.0700	0.2610
173	0.680	3853.3400	0.2595
174	0.573	3875.6100	0.2580
175	0.382	3897.8900	0.2565
176	0.186	3920.1600	0.2551
177	-0.110	3942.4300	0.2537
178	-0.251	3964.7100	0.2522
179	-0.416	3986.9800	0.2508
180	-0.348	4009.2500	0.2494

730, 1530, 2320, 3020, 3810

763.1

$c = 2670 \text{ m/s}$

$d = 1.75$

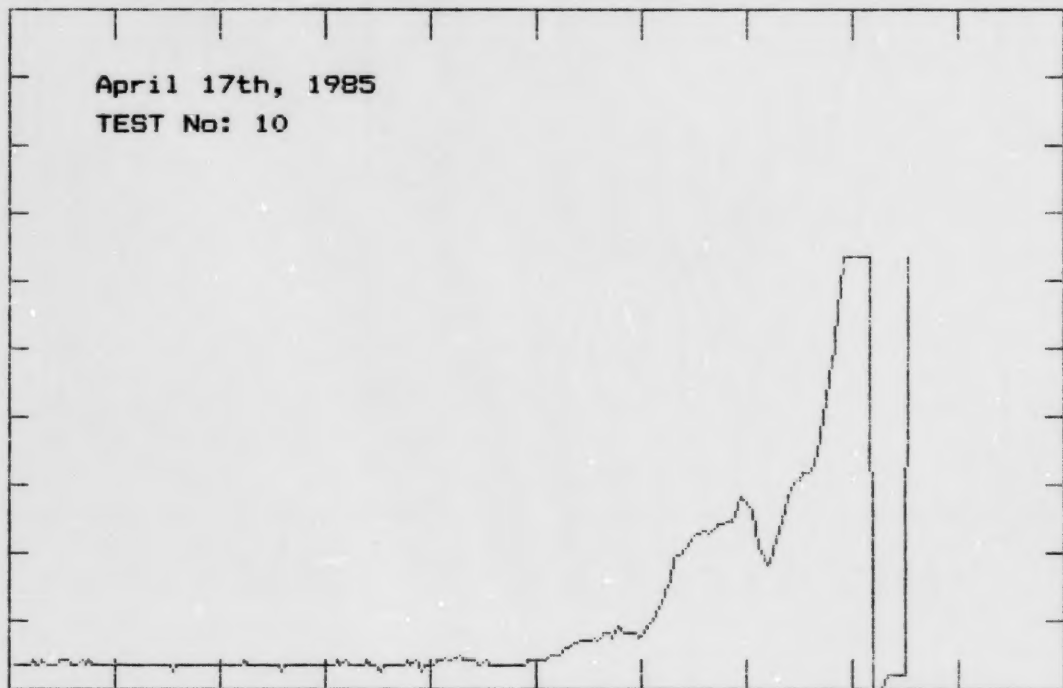
$n = 2$

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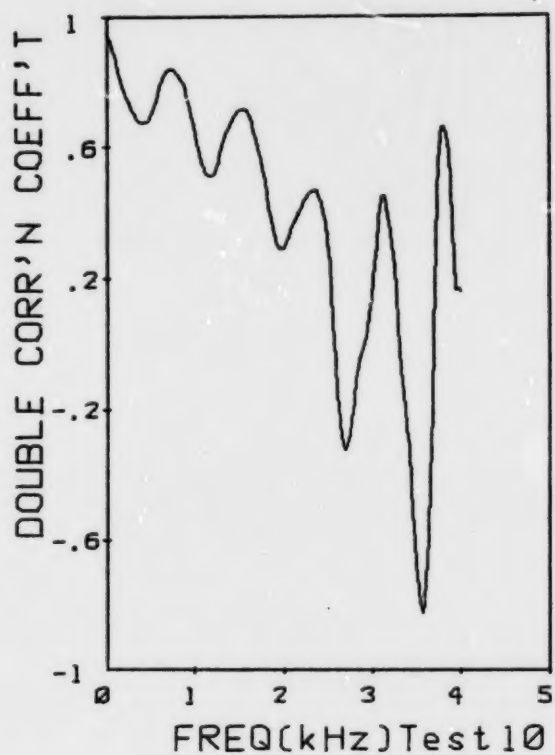
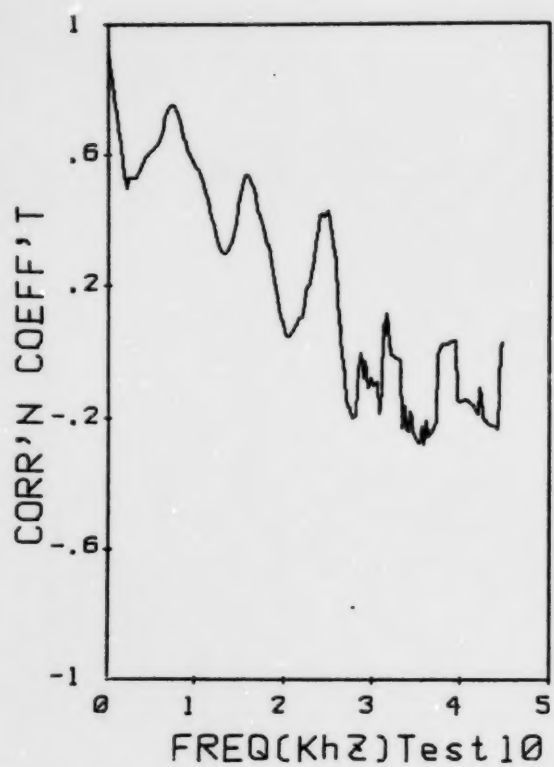
180
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April 17th, 1985
TEST No: 10



1.2 1.9 2.6 3.3 3.9 4.6 5.3 5.9 6.6

FREQUENCY (kHz)



Acoustic Signature Analysis

Source Data File: B:TEST10

Data Description Parameters

Min	Max	Axis Min	Axis Max	Axis Seg	Label
22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.922	22.3828	44.6771
2	0.878	44.7656	22.3386
3	0.831	67.1484	14.8924
4	0.781	89.5313	11.1693
5	0.733	111.9140	8.9354
6	0.684	134.2970	7.4462
7	0.631	156.6800	6.3824
8	0.580	179.0630	5.5846
9	0.535	201.4450	4.9641
10	0.492	223.8280	4.4677
11	0.534	246.2110	4.0616
12	0.529	268.5940	3.7231
13	0.528	290.9770	3.4367
14	0.529	313.3590	3.1912
15	0.534	335.7420	2.9785
16	0.544	358.1250	2.7923
17	0.558	380.5080	2.6281
18	0.575	402.8910	2.4821
19	0.587	425.2730	2.3514
20	0.600	447.6560	2.2339
21	0.607	470.0390	2.1275
22	0.613	492.4220	2.0308
23	0.617	514.8050	1.9425
24	0.625	537.1880	1.8615
25	0.631	559.5700	1.7871
26	0.641	581.9530	1.7184
27	0.654	604.3360	1.6547
28	0.671	626.7190	1.5956
29	0.694	649.1020	1.5406
30	0.718	671.4840	1.4892

32	0.753	716.2500	1.3962
33	0.760	<u>738.6330</u>	1.3539
34	0.757	761.0160	1.3140
35	0.748	783.3980	1.2765
36	0.732	805.7810	1.2410
37	0.708	828.1640	1.2075
38	0.684	850.5470	1.1757
39	0.659	872.9300	1.1456
40	0.638	895.3130	1.1169
41	0.619	917.6950	1.0897
42	0.604	940.0780	1.0637
43	0.591	962.4610	1.0390
44	0.581	984.8440	1.0154
45	0.570	1007.2300	0.9928
46	0.562	1029.6100	0.9712
47	0.551	1051.9900	0.9506
48	0.534	1074.3800	0.9308
49	0.512	1096.7600	0.9118
50	0.485	1119.1400	0.8935
51	0.459	1141.5200	0.8760
52	0.432	1163.9100	0.8592
53	0.407	1186.2900	0.8430
54	0.381	1208.6700	0.8274
55	0.353	1231.0500	0.8123
56	0.323	1253.4400	0.7978
57	0.309	1275.8200	0.7838
58	0.299	1298.2000	0.7703
59	0.292	1320.5900	0.7572
60	0.295	1342.9700	0.7446
61	0.304	1365.3500	0.7324
62	0.318	1387.7300	0.7206
63	0.337	1410.1200	0.7092
64	0.362	1432.5000	0.6981
65	0.397	1454.8800	0.6873
66	0.443	1477.2700	0.6769
67	0.470	1499.6500	0.6668
68	0.500	1522.0300	0.6570
69	0.528	1544.4100	0.6475
70	0.545	1566.8000	0.6382
71	0.544	<u>1589.1800</u>	0.6293
72	0.525	1611.5600	0.6205
73	0.509	1633.9500	0.6120
74	0.500	1656.3300	0.6037
75	0.468	1678.7100	0.5957
76	0.432	1701.0900	0.5879
77	0.412	1723.4800	0.5802
78	0.392	1745.8600	0.5728
79	0.362	1768.2400	0.5655
80	0.337	1790.6300	0.5585
81	0.317	1813.0100	0.5516
82	0.299	1835.3900	0.5448
83	0.263	1857.7700	0.5383
84	0.216	1880.1600	0.5319
85	0.188	1902.5400	0.5256
86	0.163	1924.9200	0.5195
87	0.123	1947.3000	0.5135
88	0.087	1969.6900	0.5077
89	0.084	1992.0700	0.5020
90	0.058	2014.4500	0.4964
91	0.040	2036.8400	0.4910
92	0.039	2059.2200	0.4856
93	0.059	2081.6000	0.4804
94	0.065	2103.9800	0.4753
95	0.085	2126.3700	0.4703
96	0.087	2148.7500	0.4654

97	0.105	2171.1300	0.4606
98	0.099	2193.5200	0.4559
99	0.111	2215.9000	0.4513
100	0.148	2238.2800	0.4468
101	0.189	2260.6600	0.4423
102	0.206	2283.0500	0.4380
103	0.210	2305.4300	0.4338
104	0.244	2327.8100	0.4296
105	0.285	2350.2000	0.4255
106	0.330	2372.5800	0.4215
107	0.380	2394.9600	0.4175
108	0.421	2417.3400	0.4137
109	0.428	(2439.7300)	0.4099
110	0.411	2462.1100	0.4062
111	0.429	2484.4900	0.4025
112	0.435	(2506.8800)	0.3989
113	0.402	2529.2600	0.3954
114	0.362	2551.6400	0.3919
115	0.322	2574.0200	0.3885
116	0.279	2596.4100	0.3851
117	0.146	2618.7900	0.3819
118	0.057	2641.1700	0.3786
119	-0.028	2663.5500	0.3754
120	-0.033	2685.9400	0.3723
121	-0.142	2708.3200	0.3692
122	-0.175	2730.7000	0.3662
123	-0.174	2753.0900	0.3632
124	-0.205	2775.4700	0.3603
125	-0.194	2797.8500	0.3574
126	-0.188	2820.2300	0.3546
127	-0.093	2842.6200	0.3518
128	-0.015	2865.0000	0.3490
129	0.006	(2887.3800)	0.3463
130	-0.082	2909.7700	0.3437
131	-0.019	2932.1500	0.3410
132	-0.112	2954.5300	0.3385
133	-0.092	2976.9100	0.3359
134	-0.067	2999.3000	0.3334
135	-0.104	3021.6800	0.3309
136	-0.087	3044.0600	0.3285
137	-0.080	3066.4500	0.3261
138	-0.190	3088.8300	0.3237
139	-0.112	3111.2100	0.3214
140	0.092	3133.5900	0.3191
141	0.049	3155.9800	0.3169
142	0.123	3178.3600	0.3146
143	0.068	3200.7400	0.3124
144	-0.005	3223.1300	0.3103
145	-0.011	3245.5100	0.3081
146	-0.014	3267.8900	0.3060
147	-0.019	3290.2700	0.3039
148	-0.022	3312.6600	0.3019
149	-0.025	3335.0400	0.2998
150	-0.237	3357.4200	0.2978
151	-0.156	3379.8000	0.2959
152	-0.242	3402.1900	0.2939
153	-0.245	3424.5700	0.2920
154	-0.173	3446.9500	0.2901
155	-0.239	3469.3400	0.2882
156	-0.246	3491.7200	0.2864
157	-0.258	3514.1000	0.2846
158	-0.277	3536.4800	0.2828
159	-0.282	3558.8700	0.2810
160	-0.217	3581.2500	0.2792
161	-0.286	3603.6300	0.2775
162	-0.202	3626.0200	0.2758

163	-0.258	3648.4000	0.2741
164	-0.250	3670.7800	0.2724
165	-0.242	3693.1600	0.2708
166	-0.227	3715.5500	0.2691
167	-0.206	3737.9300	0.2675
168	-0.003	3760.3100	0.2659
169	0.017	3782.7000	0.2644
170	0.024	3805.0800	0.2628
171	0.033	3827.4600	0.2613
172	0.031	3849.8400	0.2598
173	0.031	3872.2300	0.2582
174	0.034	3894.6100	0.2568
175	0.039	3916.9900	0.2553
176	0.039	3939.3800	0.2538
177	0.041	<u>3961.7600</u>	0.2524
178	-0.147	3984.1400	0.2510
179	-0.150	4006.5200	0.2496
180	-0.141	4028.9100	0.2482
181	-0.140	4051.2900	0.2468
182	-0.141	4073.6700	0.2455
183	-0.143	4096.0500	0.2441
184	-0.151	4118.4400	0.2428
185	-0.160	4140.8200	0.2415
186	-0.161	4163.2000	0.2402
187	-0.176	4185.5900	0.2389
188	-0.191	4207.9700	0.2376
189	-0.098	4230.3500	0.2364
190	-0.186	4252.7300	0.2351
191	-0.209	4275.1200	0.2339
192	-0.211	4297.5000	0.2327
193	-0.217	4319.8800	0.2315
194	-0.221	4342.2700	0.2303
195	-0.223	4364.6500	0.2291
196	-0.229	4387.0300	0.2279
197	-0.230	4409.4100	0.2268
198	-0.235	4431.8000	0.2256
199	0.026	4454.1800	0.2245
200	0.028	4476.5600	0.2234
201	0.035	4498.9500	0.2223

740, 1570, 2170, 3180, 3960

767.0

for $d = 1.75 \mu$

$C = 2654$

$n = 2$

Acoustic Signature Analysis

Source Data File: B:TEST10 Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.989	22.2736	44.8961
2	0.975	44.5473	22.4481
3	0.957	66.8209	14.9654
4	0.936	89.0945	11.2240
5	0.915	111.3680	8.9792
6	0.893	133.6420	7.4827
7	0.866	155.9150	6.4137
8	0.841	178.1890	5.6120
9	0.818	200.4630	4.9885
10	0.795	222.7360	4.4896
11	0.781	245.0100	4.0815
12	0.767	267.2840	3.7413
13	0.753	289.5570	3.4535
14	0.742	311.8310	3.2069
15	0.729	334.1050	2.9931
16	0.718	356.3780	2.8060
17	0.712	378.6520	2.6409
18	0.706	400.9250	2.4942
19	0.705	423.1990	2.3630
20	0.708	445.4730	2.2448
21	0.709	467.7460	2.1379
22	0.716	490.0200	2.0407
23	0.728	512.2940	1.9520
24	0.743	534.5670	1.8707
25	0.761	556.8410	1.7958
26	0.783	579.1140	1.7268
27	0.802	601.3880	1.6628
28	0.823	623.6620	1.6034
29	0.839	645.9350	1.5481

30	0.850	668.2090	1.4965
31	0.864	690.4830	1.4483
32	0.871	712.7560	1.4030
33	0.875	735.0300	1.3605
34	0.875	757.3030	1.3205
35	0.872	779.5770	1.2827
36	0.864	801.8510	1.2471
37	0.857	824.1240	1.2134
38	0.845	846.3980	1.1815
39	0.834	868.6720	1.1512
40	0.821	890.9450	1.1224
41	0.802	913.2190	1.0950
42	0.778	935.4930	1.0690
43	0.752	957.7660	1.0441
44	0.725	980.0400	1.0204
45	0.699	1002.3100	0.9977
46	0.671	1024.5900	0.9760
47	0.640	1046.8600	0.9552
48	0.610	1069.1300	0.9353
49	0.581	1091.4100	0.9162
50	0.559	1113.6800	0.8979
51	0.543	1135.9600	0.8803
52	0.540	1158.2300	0.8634
53	0.538	1180.5000	0.8471
54	0.541	1202.7800	0.8314
55	0.550	1225.0500	0.8163
56	0.567	1247.3200	0.8017
57	0.590	1269.6000	0.7877
58	0.613	1291.8700	0.7741
59	0.639	1314.1400	0.7610
60	0.659	1336.4200	0.7483
61	0.674	1358.6900	0.7360
62	0.689	1380.9700	0.7241
63	0.704	1403.2400	0.7126
64	0.720	1425.5100	0.7015
65	0.732	1447.7900	0.6907
66	0.740	1470.0600	0.6802
67	0.746	1492.3300	0.6701
68	0.751	1514.6100	0.6602
69	0.752	1536.8800	0.6507
70	0.753	1559.1500	0.6414
71	0.748	1581.4300	0.6323
72	0.741	1603.7000	0.6236
73	0.724	1625.9800	0.6150
74	0.702	1648.2500	0.6067
75	0.678	1670.5200	0.5986
76	0.653	1692.8000	0.5907
77	0.624	1715.0700	0.5831
78	0.592	1737.3400	0.5756
79	0.560	1759.6200	0.5683
80	0.524	1781.8900	0.5612
81	0.486	1804.1600	0.5543
82	0.445	1826.4400	0.5475
83	0.411	1848.7100	0.5409
84	0.380	1870.9900	0.5345
85	0.354	1893.2600	0.5282
86	0.334	1915.5300	0.5220
87	0.324	1937.8100	0.5160
88	0.321	1960.0800	0.5102
89	0.320	1982.3500	0.5045
90	0.329	2004.6300	0.4988
91	0.344	2026.9000	0.4934
92	0.361	2049.1700	0.4880
93	0.378	2071.4500	0.4828
94	0.394	2093.7200	0.4776
95	0.406	2116.0000	0.4726

96	0.418	2138.2700	0.4677
97	0.430	2160.5400	0.4628
98	0.444	2182.8200	0.4581
99	0.458	2205.0900	0.4535
100	0.468	2227.3600	0.4490
101	0.474	2249.6400	0.4445
102	0.482	2271.9100	0.4402
103	0.491	2294.1800	0.4359
104	0.498	2316.4600	0.4317
105	0.501	<u>2338.7300</u>	0.4276
106	0.500	2361.0000	0.4235
107	0.493	2383.2800	0.4196
108	0.478	2405.5500	0.4157
109	0.458	2427.8300	0.4119
110	0.433	2450.1000	0.4081
111	0.397	2472.3700	0.4045
112	0.343	2494.6500	0.4009
113	0.276	2516.9200	0.3973
114	0.196	2539.1900	0.3938
115	0.096	2561.4700	0.3904
116	-0.020	2583.7400	0.3870
117	-0.121	2606.0100	0.3837
118	-0.201	2628.2900	0.3805
119	-0.254	2650.5600	0.3773
120	-0.296	2672.8400	0.3741
121	-0.295	2695.1100	0.3710
122	-0.269	2717.3800	0.3680
123	-0.239	2739.6600	0.3650
124	-0.192	2761.9300	0.3621
125	-0.134	2784.2000	0.3592
126	-0.071	2806.4800	0.3563
127	-0.032	2828.7500	0.3535
128	-0.010	2851.0300	0.3508
129	0.000	2873.3000	0.3480
130	0.028	2895.5700	0.3454
131	0.040	2917.8500	0.3427
132	0.081	2940.1200	0.3401
133	0.129	2962.3900	0.3376
134	0.174	2984.6700	0.3350
135	0.231	3006.9400	0.3326
136	0.283	3029.2100	0.3301
137	0.332	3051.4900	0.3277
138	0.419	3073.7600	0.3253
139	0.479	3096.0400	0.3230
140	0.487	<u>3118.3100</u>	0.3207
141	0.485	3140.5800	0.3184
142	0.454	3162.8600	0.3162
143	0.414	3185.1300	0.3140
144	0.374	3207.4000	0.3118
145	0.328	3229.6800	0.3096
146	0.266	3251.9500	0.3075
147	0.184	3274.2200	0.3054
148	0.081	3296.5000	0.3034
149	-0.046	3318.7700	0.3013
150	-0.083	3341.0500	0.2993
151	-0.166	3363.3200	0.2973
152	-0.226	3385.5900	0.2954
153	-0.286	3407.8700	0.2934
154	-0.400	3430.1400	0.2915
155	-0.485	3452.4100	0.2897
156	-0.569	3474.6900	0.2878
157	-0.644	3496.9600	0.2860
158	-0.720	3519.2300	0.2842
159	-0.761	3541.5100	0.2824
160	-0.793	3563.7800	0.2806
161	-0.747	3586.0500	0.2789

162	-0.688	3608.3300	0.2771
163	-0.554	3630.6000	0.2754
164	-0.378	3652.8800	0.2738
165	-0.165	3675.1500	0.2721
166	0.078	3697.4200	0.2705
167	0.340	3719.7000	0.2688
168	0.484	3741.9700	0.2672
169	0.592	3764.2400	0.2657
170	0.664	3786.5200	0.2641
171	0.696	<u>3808.7900</u>	0.2626
172	0.696	<u>3831.0700</u>	0.2610
173	0.667	3853.3400	0.2595
174	0.610	3875.6100	0.2580
175	0.519	3897.8900	0.2565
176	0.383	3920.1600	0.2551
177	0.189	3942.4300	0.2537
178	0.204	3964.7100	0.2522
179	0.194	3986.9800	0.2508
180	0.184	4009.2500	0.2494

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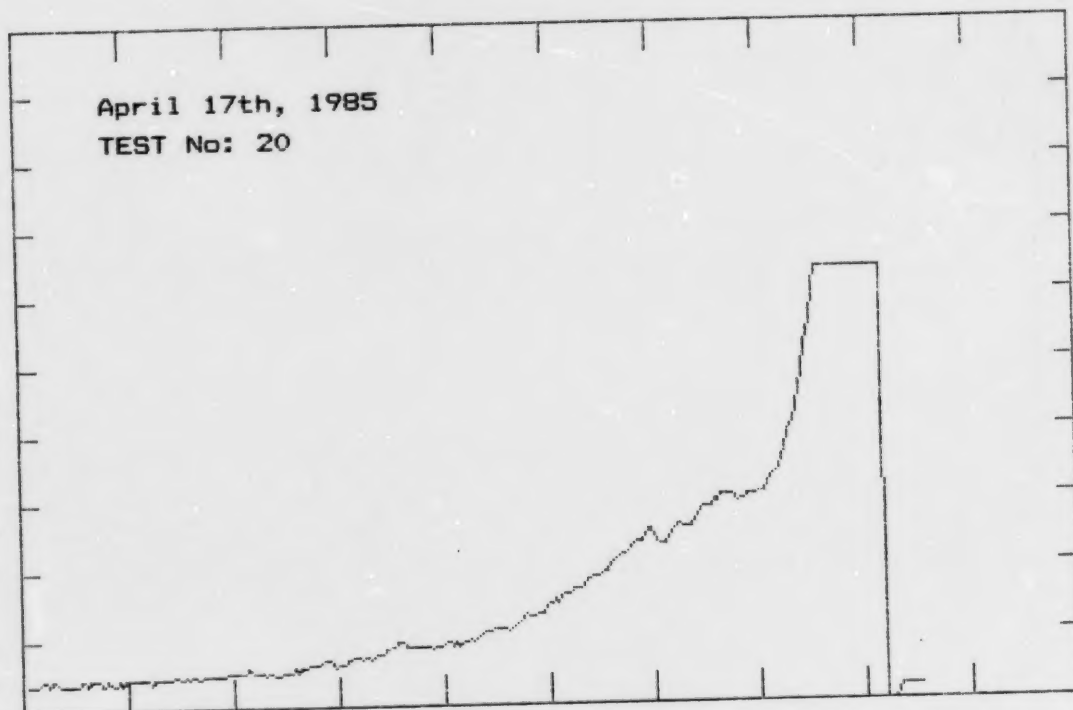
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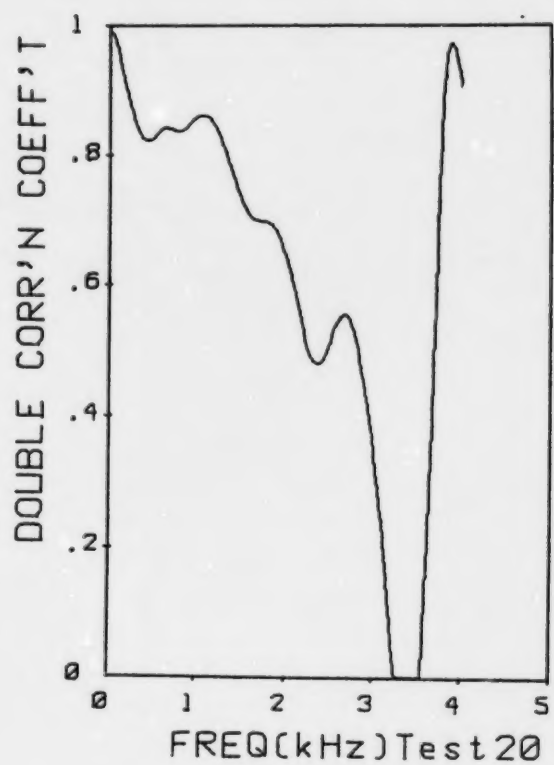
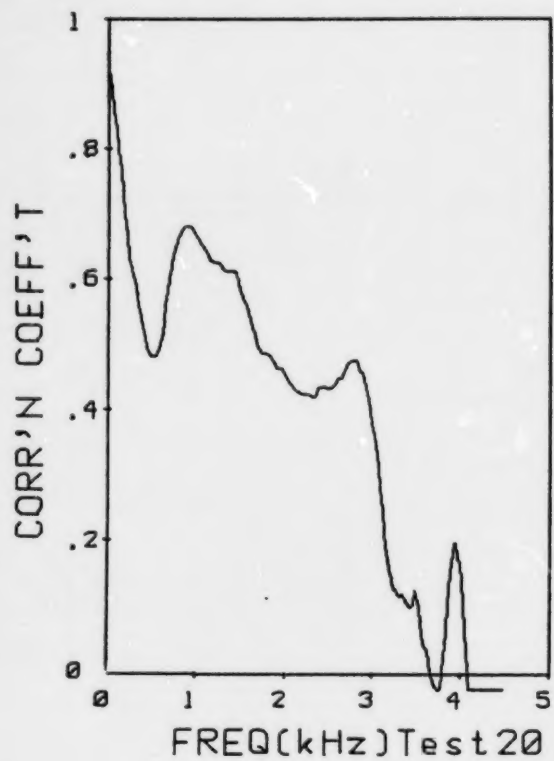
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April 17th, 1985
TEST No: 20

1.2 1.9 2.6 3.3 3.9 4.6 5.3 5.9 6.6

FREQUENCY (kHz)





Acoustic Signature Analysis

Source Data File: B:TEST20

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.973	22.3828	44.6771
2	0.944	44.7656	22.3386
3	0.914	67.1484	14.8924
4	0.883	89.5313	11.1693
5	0.853	111.9140	8.9354
6	0.822	134.2970	7.4462
7	0.790	156.6800	6.3824
8	0.757	179.0630	5.5846
9	0.724	201.4450	4.9641
10	0.690	223.8280	4.4677
11	0.655	246.2110	4.0616
12	0.642	268.5940	3.7231
13	0.627	290.9770	3.4367
14	0.613	313.3590	3.1912
15	0.598	335.7420	2.9785
16	0.583	358.1250	2.7923
17	0.567	380.5080	2.6281
18	0.551	402.8910	2.4821
19	0.534	425.2730	2.3514
20	0.521	447.6560	2.2339
21	0.512	470.0390	2.1275
22	0.506	492.4220	2.0308
23	0.504	514.8050	1.9425
24	0.506	537.1880	1.8615
25	0.511	559.5700	1.7871
26	0.519	581.9530	1.7184
27	0.530	604.3360	1.6547
28	0.545	626.7190	1.5956
29	0.564	649.1020	1.5406
30	0.588	671.4840	1.4892

31	0.610	693.8670	1.4412
32	0.629	716.2500	1.3962
33	0.647	738.6330	1.3539
34	0.663	761.0160	1.3140
35	0.675	783.3980	1.2765
36	0.686	805.7810	1.2410
37	0.695	828.1640	1.2075
38	0.701	850.5470	1.1757
39	0.704	872.9300	1.1456
40	0.706	895.3130	1.1169
41	0.707	917.6950	1.0897
42	0.707	940.0780	1.0637
43	0.704	962.4610	1.0390
44	0.700	984.8440	1.0154
45	0.694	1007.2300	0.9928
46	0.688	1029.6100	0.9712
47	0.683	1051.9900	0.9506
48	0.677	1074.3800	0.9308
49	0.673	1096.7600	0.9118
50	0.668	1119.1400	0.8935
51	0.661	1141.5200	0.8760
52	0.655	1163.9100	0.8592
53	0.651	1186.2900	0.8430
54	0.649	1208.6700	0.8274
55	0.648	1231.0500	0.8123
56	0.648	1253.4400	0.7978
57	0.647	1275.8200	0.7838
58	0.643	1298.2000	0.7703
59	0.639	1320.5900	0.7572
60	0.636	1342.9700	0.7446
61	0.635	1365.3500	0.7324
62	0.637	1387.7300	0.7206
63	0.637	1410.1200	0.7092
64	0.636	1432.5000	0.6981
65	0.631	1454.8800	0.6873
66	0.620	1477.2700	0.6769
67	0.608	1499.6500	0.6668
68	0.597	1522.0300	0.6570
69	0.589	1544.4100	0.6475
70	0.582	1566.8000	0.6382
71	0.572	1589.1800	0.6293
72	0.562	1611.5600	0.6205
73	0.550	1633.9500	0.6120
74	0.539	1656.3300	0.6037
75	0.527	1678.7100	0.5957
76	0.518	1701.0900	0.5879
77	0.513	1723.4800	0.5802
78	0.510	1745.8600	0.5728
79	0.510	1768.2400	0.5655
80	0.506	1790.6300	0.5585
81	0.505	1813.0100	0.5516
82	0.502	1835.3900	0.5448
83	0.498	1857.7700	0.5383
84	0.494	1880.1600	0.5319
85	0.487	1902.5400	0.5256
86	0.488	1924.9200	0.5195
87	0.487	1947.3000	0.5135
88	0.484	1969.6900	0.5077
89	0.479	1992.0700	0.5020
90	0.473	2014.4500	0.4964
91	0.467	2036.8400	0.4910
92	0.461	2059.2200	0.4856
93	0.459	2081.6000	0.4804
94	0.455	2103.9800	0.4753
95	0.451	2126.3700	0.4703
96	0.451	2148.7500	0.4654

97	0.449	2171.1300	0.4606
98	0.448	2193.5200	0.4559
99	0.447	2215.9000	0.4513
100	0.449	2238.2800	0.4468
101	0.450	2260.6600	0.4423
102	0.447	2283.0500	0.4380
103	0.445	2305.4300	0.4338
104	0.443	2327.8100	0.4296
105	0.447	2350.2000	0.4255
106	0.454	2372.5800	0.4215
107	0.462	2394.9600	0.4175
108	0.461	2417.3400	0.4137
109	0.460	2439.7300	0.4099
110	0.458	2462.1100	0.4062
111	0.454	2484.4900	0.4025
112	0.455	2506.8800	0.3989
113	0.460	2529.2600	0.3954
114	0.461	2551.6400	0.3919
115	0.464	2574.0200	0.3885
116	0.469	2596.4100	0.3851
117	0.475	2618.7900	0.3819
118	0.472	2641.1700	0.3786
119	0.478	2663.5500	0.3754
120	0.483	2685.9400	0.3723
121	0.493	2708.3200	0.3692
122	0.497	2730.7000	0.3662
123	0.502	2753.0900	0.3632
124	0.500	2775.4700	0.3603
125	0.499	2797.8500	0.3574
126	0.498	2820.2300	0.3546
127	0.492	2842.6200	0.3518
128	0.481	2865.0000	0.3490
129	0.482	2887.3800	0.3463
130	0.470	2909.7700	0.3437
131	0.458	2932.1500	0.3410
132	0.439	2954.5300	0.3385
133	0.425	2976.9100	0.3359
134	0.404	2999.3000	0.3334
135	0.387	3021.6800	0.3309
136	0.370	3044.0600	0.3285
137	0.338	3066.4500	0.3261
138	0.305	3088.8300	0.3237
139	0.270	3111.2100	0.3214
140	0.238	3133.5900	0.3191
141	0.218	3155.9800	0.3169
142	0.196	3178.3600	0.3146
143	0.183	3200.7400	0.3124
144	0.168	3223.1300	0.3103
145	0.151	3245.5100	0.3081
146	0.153	3267.8900	0.3060
147	0.144	3290.2700	0.3039
148	0.141	3312.6600	0.3019
149	0.149	3335.0400	0.2998
150	0.145	3357.4200	0.2978
151	0.135	3379.8000	0.2959
152	0.130	3402.1900	0.2939
153	0.124	3424.5700	0.2920
154	0.128	3446.9500	0.2901
155	0.133	3469.3400	0.2882
156	0.155	3491.7200	0.2864
157	0.143	3514.1000	0.2846
158	0.124	3536.4800	0.2828
159	0.103	3558.8700	0.2810
160	0.069	3581.2500	0.2792
161	0.065	3603.6300	0.2775
162	0.062	3626.0200	0.2758

163	0.045	3648.4000	0.2741
164	0.026	3670.7800	0.2724
165	0.016	3693.1600	0.2708
166	0.005	3715.5500	0.2691
167	0.004	3737.9300	0.2675
168	-0.010	3760.3100	0.2659
169	0.010	3782.7000	0.2644
170	0.032	3805.0800	0.2628
171	0.054	3827.4600	0.2613
172	0.093	3849.8400	0.2598
173	0.135	3872.2300	0.2582
174	0.180	3894.6100	0.2568
175	0.198	3916.9900	0.2553
176	0.228	3939.3800	0.2538
177	0.225	3961.7600	0.2524
178	0.198	3984.1400	0.2510
179	0.194	4006.5200	0.2496
180	0.165	4028.9100	0.2482
181	0.093	4051.2900	0.2468
182	0.058	4073.6700	0.2455
183	-0.003	4096.0500	0.2441
184	-0.068	4118.4400	0.2428
185	-0.130	4140.8200	0.2415
186	-0.175	4163.2000	0.2402
187	-0.242	4185.5900	0.2389
188	-0.249	4207.9700	0.2376
189	-0.257	4230.3500	0.2364
190	-0.267	4252.7300	0.2351
191	-0.275	4275.1200	0.2339
192	-0.270	4297.5000	0.2327
193	-0.282	4319.8800	0.2315
194	-0.297	4342.2700	0.2303
195	-0.259	4364.6500	0.2291
196	-0.278	4387.0300	0.2279
197	-0.301	4409.4100	0.2268
198	-0.264	4431.8000	0.2256
199	-0.319	4454.1800	0.2245
200	-0.305	4476.5600	0.2234
201	-0.359	4498.9500	0.2223

930, 2760, 3940
945

$c = 3307 \text{ m/s}$
 $d = 1.75$
 $n = 2$

Acoustic Signature Analysis

Source Data File: B:TEST20 Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.998	22.2736	44.8961
2	0.994	44.5473	22.4481
3	0.986	66.8209	14.9654
4	0.977	89.0945	11.2240
5	0.965	111.3680	8.9792
6	0.952	133.6420	7.4827
7	0.937	155.9150	6.4137
8	0.922	178.1890	5.6120
9	0.908	200.4630	4.9885
10	0.894	222.7360	4.4896
11	0.881	245.0100	4.0815
12	0.870	267.2840	3.7413
13	0.859	289.5570	3.4535
14	0.850	311.8310	3.2069
15	0.843	334.1050	2.9931
16	0.836	356.3780	2.8060
17	0.831	378.6520	2.6409
18	0.827	400.9250	2.4942
19	0.824	423.1990	2.3630
20	0.823	445.4730	2.2448
21	0.824	467.7460	2.1379
22	0.826	490.0200	2.0407
23	0.829	512.2940	1.9520
24	0.832	534.5670	1.8707
25	0.836	556.8410	1.7958
26	0.841	579.1140	1.7268
27	0.843	601.3880	1.6628
28	0.845	623.6620	1.6034
29	0.846	645.9350	1.5481

30	0.845	668.2090	1.4965
31	0.844	690.4830	1.4483
32	0.842	712.7560	1.4030
33	0.841	735.0300	1.3605
34	0.840	757.3030	1.3205
35	0.839	779.5770	1.2827
36	0.839	801.8510	1.2471
37	0.840	824.1240	1.2134
38	0.842	846.3980	1.1815
39	0.844	868.6720	1.1512
40	0.847	890.9450	1.1224
41	0.850	913.2190	1.0950
42	0.853	935.4930	1.0690
43	0.856	957.7660	1.0441
44	0.860	980.0400	1.0204
45	0.862	1002.3100	0.9977
46	0.865	1024.5900	0.9760
47	0.866	1046.8600	0.9552
48	0.866	1069.1300	0.9353
49	0.866	1091.4100	0.9162
50	0.864	1113.6800	0.8979
51	0.861	1135.9600	0.8803
52	0.858	1158.2300	0.8634
53	0.854	1180.5000	0.8471
54	0.849	1202.7800	0.8314
55	0.843	1225.0500	0.8163
56	0.836	1247.3200	0.8017
57	0.829	1269.6000	0.7877
58	0.821	1291.8700	0.7741
59	0.812	1314.1400	0.7610
60	0.803	1336.4200	0.7483
61	0.794	1358.6900	0.7360
62	0.783	1380.9700	0.7241
63	0.772	1403.2400	0.7126
64	0.761	1425.5100	0.7015
65	0.751	1447.7900	0.6907
66	0.742	1470.0600	0.6802
67	0.733	1492.3300	0.6701
68	0.726	1514.6100	0.6602
69	0.719	1536.8800	0.6507
70	0.713	1559.1500	0.6414
71	0.708	1581.4300	0.6323
72	0.704	1603.7000	0.6236
73	0.702	1625.9800	0.6150
74	0.699	1648.2500	0.6067
75	0.698	1670.5200	0.5986
76	0.698	(1692.8000)	0.5907
77	0.698	1715.0700	0.5831
78	0.697	1737.3400	0.5756
79	0.697	1759.6200	0.5683
80	0.696	1781.8900	0.5612
81	0.695	1804.1600	0.5543
82	0.693	1826.4400	0.5475
83	0.690	1848.7100	0.5409
84	0.686	1870.9900	0.5345
85	0.682	1893.2600	0.5282
86	0.677	1915.5300	0.5220
87	0.670	1937.8100	0.5160
88	0.662	1960.0800	0.5102
89	0.654	1982.3500	0.5045
90	0.644	2004.6300	0.4988
91	0.634	2026.9000	0.4934
92	0.623	2049.1700	0.4880
93	0.611	2071.4500	0.4828
94	0.598	2093.7200	0.4776
95	0.586	2116.0000	0.4726

96	0.572	2138.2700	0.4677
97	0.557	2160.5400	0.4628
98	0.543	2182.8200	0.4581
99	0.529	2205.0900	0.4535
100	0.516	2227.3600	0.4490
101	0.505	2249.6400	0.4445
102	0.496	2271.9100	0.4402
103	0.488	2294.1800	0.4359
104	0.484	2316.4600	0.4317
105	0.480	2338.7300	0.4276
106	0.479	2361.0000	0.4235
107	0.479	2383.2800	0.4196
108	0.481	2405.5500	0.4157
109	0.485	2427.8300	0.4119
110	0.490	2450.1000	0.4081
111	0.498	2472.3700	0.4045
112	0.507	2494.6500	0.4009
113	0.516	2516.9200	0.3973
114	0.525	2539.1900	0.3938
115	0.534	2561.4700	0.3904
116	0.542	2583.7400	0.3870
117	0.547	2606.0100	0.3837
118	0.553	2628.2900	0.3805
119	0.557	2650.5600	0.3773
120	0.559	2672.8400	0.3741
121	0.558	2695.1100	0.3710
122	0.554	2717.3800	0.3680
123	0.549	2739.6600	0.3650
124	0.541	2761.9300	0.3621
125	0.531	2784.2000	0.3592
126	0.518	2806.4800	0.3563
127	0.504	2828.7500	0.3535
128	0.489	2851.0300	0.3508
129	0.472	2873.3000	0.3480
130	0.455	2895.5700	0.3454
131	0.436	2917.8500	0.3427
132	0.416	2940.1200	0.3401
133	0.394	2962.3900	0.3376
134	0.370	2984.6700	0.3350
135	0.344	3006.9400	0.3326
136	0.316	3029.2100	0.3301
137	0.290	3051.4900	0.3277
138	0.264	3073.7600	0.3253
139	0.239	3096.0400	0.3230
140	0.213	3118.3100	0.3207
141	0.184	3140.5800	0.3184
142	0.153	3162.8600	0.3162
143	0.119	3185.1300	0.3140
144	0.084	3207.4000	0.3118
145	0.051	3229.6800	0.3096
146	0.014	3251.9500	0.3075
147	-0.022	3274.2200	0.3054
148	-0.057	3296.5000	0.3034
149	-0.093	3318.7700	0.3013
150	-0.126	3341.0500	0.2993
151	-0.149	3363.3200	0.2973
152	-0.164	3385.5900	0.2954
153	-0.169	3407.8700	0.2934
154	-0.168	3430.1400	0.2915
155	-0.160	3452.4100	0.2897
156	-0.152	3474.6900	0.2878
157	-0.133	3496.9600	0.2860
158	-0.102	3519.2300	0.2842
159	-0.058	3541.5100	0.2824
160	0.003	3563.7800	0.2806
161	0.068	3586.0500	0.2789

162	0.138	3608.3300	0.2771
163	0.215	3630.6000	0.2754
164	0.301	3652.8800	0.2738
165	0.391	3675.1500	0.2721
166	0.484	3697.4200	0.2705
167	0.577	3719.7000	0.2688
168	0.672	3741.9700	0.2672
169	0.757	3764.2400	0.2657
170	0.830	3786.5200	0.2641
171	0.891	3808.7900	0.2626
172	0.934	3831.0700	0.2610
173	0.962	3853.3400	0.2595
174	0.975	3875.6100	0.2580
175	0.978	<u>3897.8900</u>	0.2565
176	0.973	3920.1600	0.2551
177	0.963	3942.4300	0.2537
178	0.947	3964.7100	0.2522
179	0.929	3986.9800	0.2508
180	0.912	4009.2500	0.2494

1070, (1700), 2680, 3900

979

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d = 1.75

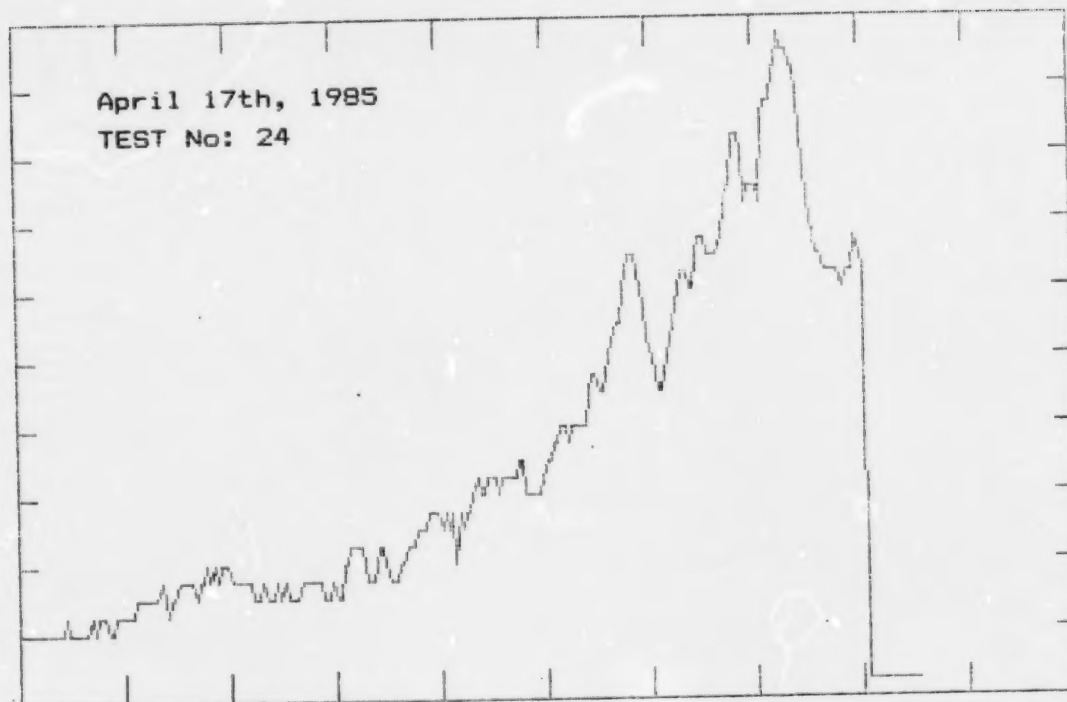
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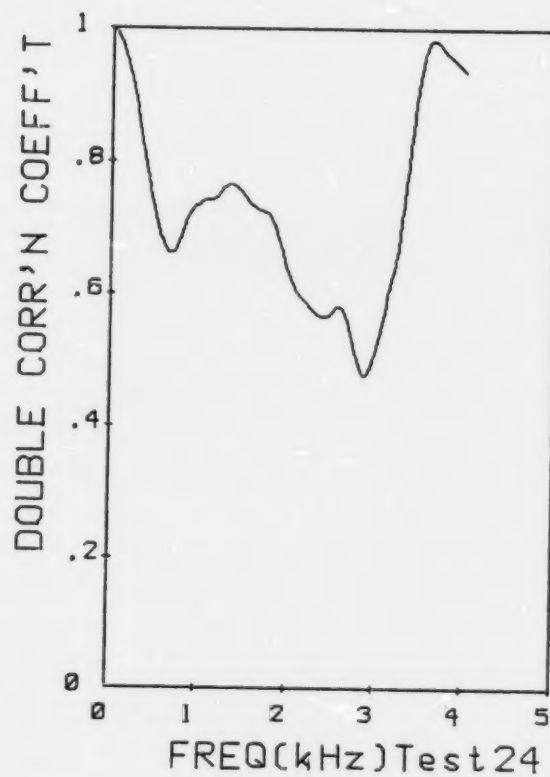
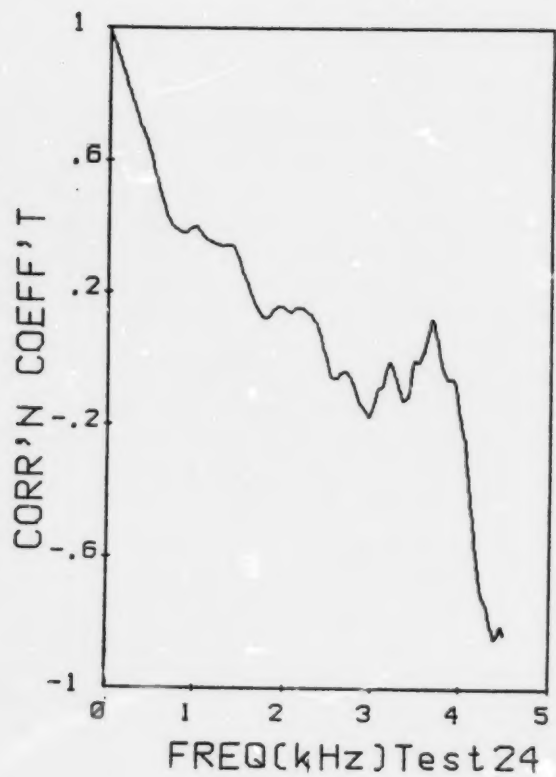
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April 17th, 1985
TEST No: 24



1.2 1.9 2.6 3.3 3.9 4.6 5.3 5.9 6.6

FREQUENCY (kHz)



Acoustic Signature Analysis

Source Data File: B:TEST24

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.983	22.3828	44.6771
2	0.965	44.7656	22.3386
3	0.944	67.1484	14.8924
4	0.924	89.5313	11.1693
5	0.903	111.9140	8.9354
6	0.882	134.2970	7.4462
7	0.863	156.6800	6.3824
8	0.844	179.0630	5.5846
9	0.825	201.4450	4.9641
10	0.806	223.8280	4.4677
11	0.787	246.2110	4.0616
12	0.769	268.5940	3.7231
13	0.749	290.9770	3.4367
14	0.729	313.3590	3.1912
15	0.708	335.7420	2.9785
16	0.699	358.1250	2.7923
17	0.688	380.5080	2.6281
18	0.673	402.8910	2.4821
19	0.653	425.2730	2.3514
20	0.631	447.6560	2.2339
21	0.609	470.0390	2.1275
22	0.585	492.4220	2.0308
23	0.562	514.8050	1.9425
24	0.539	537.1880	1.8615
25	0.517	559.5700	1.7871
26	0.495	581.9530	1.7184
27	0.476	604.3360	1.6547
28	0.456	626.7190	1.5956
29	0.438	649.1020	1.5406

30	0.426	671.4840	1.4892
31	0.413	693.8670	1.4412
32	0.402	716.2500	1.3962
33	0.395	738.6330	1.3539
34	0.392	761.0160	1.3140
35	0.387	783.3980	1.2765
36	0.382	805.7810	1.2410
37	0.378	828.1640	1.2075
38	0.380	850.5470	1.1757
39	0.383	872.9300	1.1456
40	0.386	895.3130	1.1169
41	0.393	917.6950	1.0897
42	0.397	940.0780	1.0637
43	0.400	962.4610	1.0390
44	0.401	984.8440	1.0154
45	0.395	1007.2300	0.9928
46	0.386	1029.6100	0.9712
47	0.377	1051.9900	0.9506
48	0.368	1074.3800	0.9308
49	0.360	1096.7600	0.9118
50	0.357	1119.1400	0.8935
51	0.354	1141.5200	0.8760
52	0.352	1163.9100	0.8592
53	0.347	1186.2900	0.8430
54	0.344	1208.6700	0.8274
55	0.342	1231.0500	0.8123
56	0.339	1253.4400	0.7978
57	0.339	1275.8200	0.7838
58	0.342	1298.2000	0.7703
59	0.344	1320.5900	0.7572
60	0.345	1342.9700	0.7446
61	0.344	1365.3500	0.7324
62	0.343	1387.7300	0.7206
63	0.334	1410.1200	0.7092
64	0.319	1432.5000	0.6981
65	0.301	1454.8800	0.6873
66	0.284	1477.2700	0.6769
67	0.266	1499.6500	0.6668
68	0.248	1522.0300	0.6570
69	0.230	1544.4100	0.6475
70	0.217	1566.8000	0.6382
71	0.201	1589.1800	0.6293
72	0.184	1611.5600	0.6205
73	0.166	1633.9500	0.6120
74	0.153	1656.3300	0.6037
75	0.143	1678.7100	0.5957
76	0.135	1701.0900	0.5879
77	0.124	1723.4800	0.5802
78	0.119	1745.8600	0.5728
79	0.117	1768.2400	0.5655
80	0.123	1790.6300	0.5585
81	0.131	1813.0100	0.5516
82	0.141	1835.3900	0.5448
83	0.149	1857.7700	0.5383
84	0.153	1880.1600	0.5319
85	0.156	1902.5400	0.5256
86	0.155	1924.9200	0.5195
87	0.152	1947.3000	0.5135
88	0.148	1969.6900	0.5077
89	0.142	1992.0700	0.5020
90	0.139	2014.4500	0.4964
91	0.134	2036.8400	0.4910
92	0.138	2059.2200	0.4856
93	0.147	2081.6000	0.4804
94	0.154	2103.9800	0.4753
95	0.153	2126.3700	0.4703

96	0.154	2148.7500	0.4654
97	0.154	2171.1300	0.4606
98	0.148	2193.5200	0.4559
99	0.140	2215.9000	0.4513
100	0.134	2238.2800	0.4468
101	0.131	2260.6600	0.4423
102	0.127	2283.0500	0.4380
103	0.119	2305.4300	0.4338
104	0.109	2327.8100	0.4296
105	0.100	2350.2000	0.4255
106	0.082	2372.5800	0.4215
107	0.059	2394.9600	0.4175
108	0.032	2417.3400	0.4137
109	0.013	2439.7300	0.4099
110	-0.007	2462.1100	0.4062
111	-0.036	2484.4900	0.4025
112	-0.056	2506.8800	0.3989
113	-0.062	2529.2600	0.3954
114	-0.066	2551.6400	0.3919
115	-0.061	2574.0200	0.3885
116	-0.065	2596.4100	0.3851
117	-0.044	2618.7900	0.3819
118	-0.046	2641.1700	0.3786
119	-0.038	2663.5500	0.3754
120	-0.045	2685.9400	0.3723
121	-0.046	2708.3200	0.3692
122	-0.056	2730.7000	0.3662
123	-0.066	2753.0900	0.3632
124	-0.083	2775.4700	0.3603
125	-0.105	2797.8500	0.3574
126	-0.113	2820.2300	0.3546
127	-0.126	2842.6200	0.3518
128	-0.142	2865.0000	0.3490
129	-0.148	2887.3800	0.3463
130	-0.161	2909.7700	0.3437
131	-0.166	2932.1500	0.3410
132	-0.180	2954.5300	0.3385
133	-0.170	2976.9100	0.3359
134	-0.154	2999.3000	0.3334
135	-0.126	3021.6800	0.3309
136	-0.107	3044.0600	0.3285
137	-0.091	3066.4500	0.3261
138	-0.090	3088.8300	0.3237
139	-0.082	3111.2100	0.3214
140	-0.061	3133.5900	0.3191
141	-0.039	3155.9800	0.3169
142	-0.020	3178.3600	0.3146
143	-0.012	3200.7400	0.3124
144	-0.028	3223.1300	0.3103
145	-0.048	3245.5100	0.3081
146	-0.063	3267.8900	0.3060
147	-0.093	3290.2700	0.3039
148	-0.107	3312.6600	0.3019
149	-0.132	3335.0400	0.2998
150	-0.125	3357.4200	0.2978
151	-0.120	3379.8000	0.2959
152	-0.115	3402.1900	0.2939
153	-0.074	3424.5700	0.2920
154	-0.036	3446.9500	0.2901
155	-0.006	3469.3400	0.2882
156	-0.011	3491.7200	0.2864
157	-0.014	3514.1000	0.2846
158	-0.010	3536.4800	0.2828
159	0.008	3558.8700	0.2810
160	0.026	3581.2500	0.2792
161	0.042	3603.6300	0.2775

162	0.076	3626.0200	0.2758
163	0.097	3648.4000	0.2741
164	0.123	3670.7800	0.2724
165	0.105	3693.1600	0.2708
166	0.065	3715.5500	0.2691
167	0.055	3737.9300	0.2675
168	0.012	3760.3100	0.2659
169	-0.013	3782.7000	0.2644
170	-0.039	3805.0800	0.2628
171	-0.046	3827.4600	0.2613
172	-0.065	3849.8400	0.2598
173	-0.065	3872.2300	0.2582
174	-0.063	3894.6100	0.2568
175	-0.062	3916.9900	0.2553
176	-0.080	3939.3800	0.2538
177	-0.116	3961.7600	0.2524
178	-0.155	3984.1400	0.2510
179	-0.192	4006.5200	0.2496
180	-0.228	4028.9100	0.2482
181	-0.248	4051.2900	0.2468
182	-0.311	4073.6700	0.2455
183	-0.368	4096.0500	0.2441
184	-0.440	4118.4400	0.2428
185	-0.488	4140.8200	0.2415
186	-0.559	4163.2000	0.2402
187	-0.594	4185.5900	0.2389
188	-0.656	4207.9700	0.2376
189	-0.696	4230.3500	0.2364
190	-0.732	4252.7300	0.2351
191	-0.735	4275.1200	0.2339
192	-0.754	4297.5000	0.2327
193	-0.778	4319.8800	0.2315
194	-0.806	4342.2700	0.2303
195	-0.825	4364.6500	0.2291
196	-0.850	4387.0300	0.2279
197	-0.843	4409.4100	0.2268
198	-0.837	4431.8000	0.2256
199	-0.805	4454.1800	0.2245
200	-0.810	4476.5600	0.2234
201	-0.839	4498.9500	0.2223

(980), (1910), (2140), (2660), 3200, 3670, (4450)

Acoustic Signature Analysis

Source Data File: B:TEST24 *Double* Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

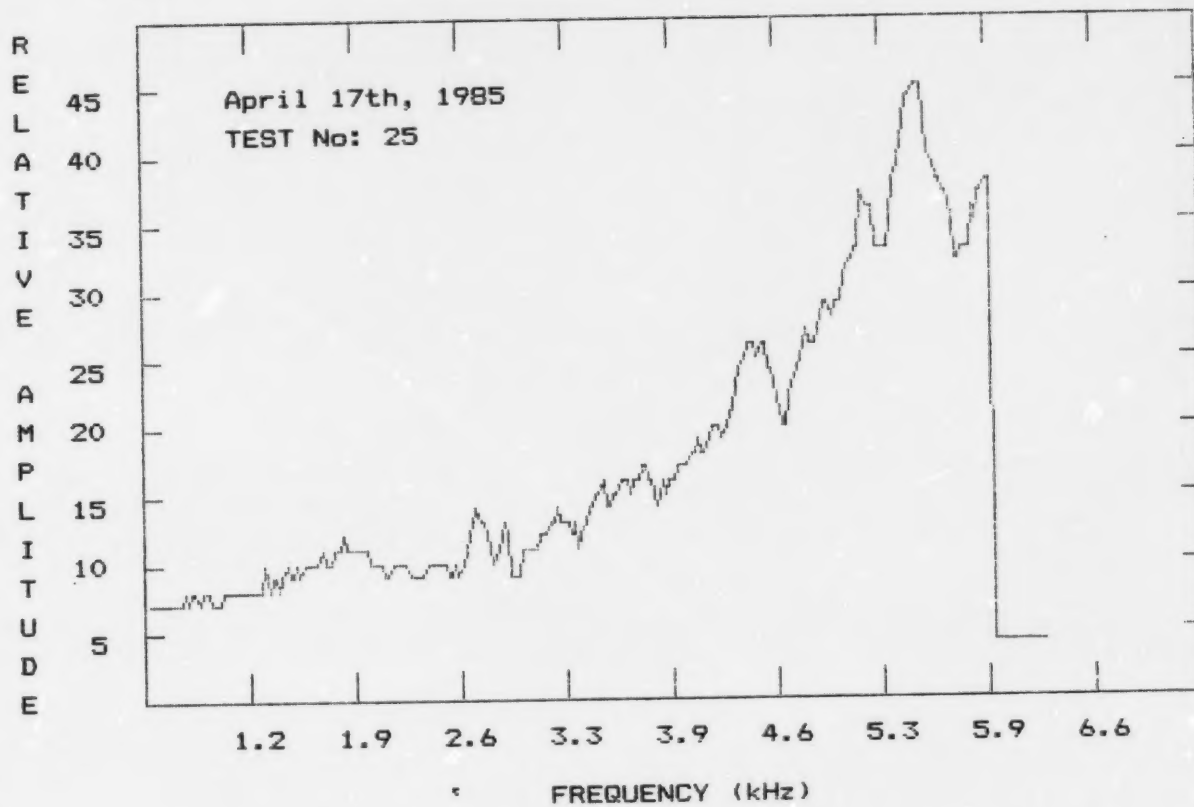
Element	Amplitude	Frequency	Period (x1000)
1	0.999	22.2736	44.8961
2	0.996	44.5473	22.4481
3	0.991	66.8209	14.9654
4	0.985	89.0945	11.2240
5	0.978	111.3680	8.9792
6	0.969	133.6420	7.4827
7	0.960	155.9150	6.4137
8	0.949	178.1890	5.6120
9	0.937	200.4630	4.9885
10	0.924	222.7360	4.4896
11	0.910	245.0100	4.0815
12	0.894	267.2840	3.7413
13	0.878	289.5570	3.4535
14	0.862	311.8310	3.2069
15	0.845	334.1050	2.9931
16	0.827	356.3780	2.8060
17	0.810	378.6520	2.6409
18	0.792	400.9250	2.4942
19	0.775	423.1990	2.3630
20	0.758	445.4730	2.2448
21	0.743	467.7460	2.1379
22	0.727	490.0200	2.0407
23	0.713	512.2940	1.9520
24	0.700	534.5670	1.8707
25	0.689	556.8410	1.7958
26	0.680	579.1140	1.7268
27	0.674	601.3880	1.6628
28	0.668	623.6620	1.6034
29	0.663	645.9350	1.5481
30	0.660	668.2090	1.4965

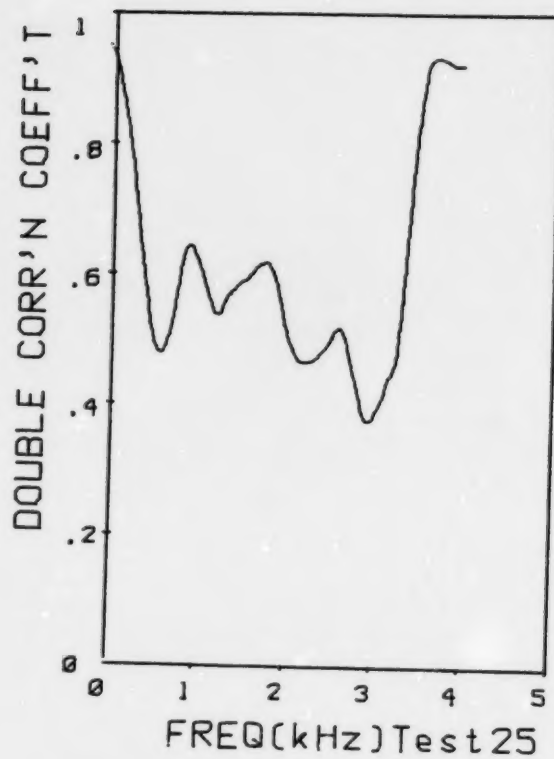
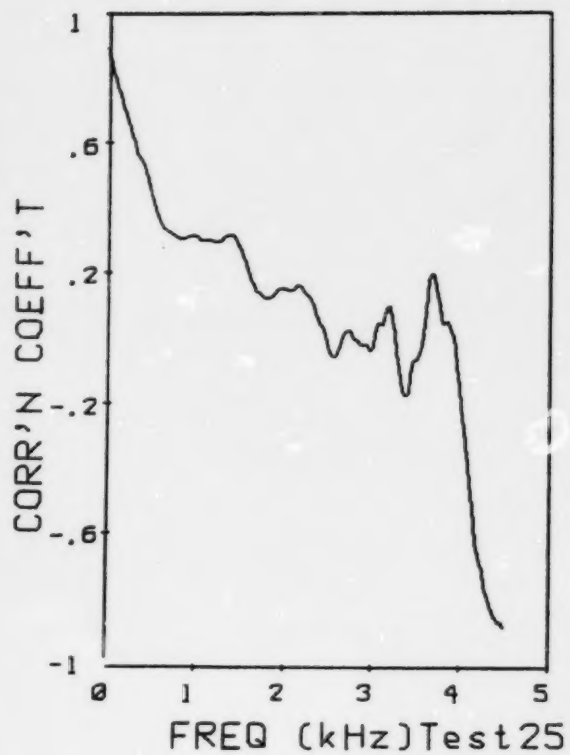
31	0.659	690.4830	1.4483
32	0.660	712.7560	1.4030
33	0.663	735.0300	1.3605
34	0.668	757.3030	1.3205
35	0.675	779.5770	1.2827
36	0.683	801.8510	1.2471
37	0.694	824.1240	1.2134
38	0.704	846.3980	1.1815
39	0.713	868.6720	1.1512
40	0.720	890.9450	1.1224
41	0.725	913.2190	1.0950
42	0.729	935.4930	1.0690
43	0.732	957.7660	1.0441
44	0.733	980.0400	1.0204
45	0.735	1002.3100	0.9977
46	0.737	1024.5900	0.9760
47	0.740	1046.8600	0.9552
48	0.742	1069.1300	0.9353
49	0.743	1091.4100	0.9162
50	0.743	1113.6800	0.8979
51	0.743	1135.9600	0.8803
52	0.744	1158.2300	0.8634
53	0.744	1180.5000	0.8471
54	0.746	1202.7800	0.8314
55	0.749	1225.0500	0.8163
56	0.753	1247.3200	0.8017
57	0.757	1269.6000	0.7877
58	0.761	1291.8700	0.7741
59	0.764	1314.1400	0.7610
60	0.766	1336.4200	0.7483
61	0.767	1358.6900	0.7360
62	0.766	1380.9700	0.7241
63	0.763	1403.2400	0.7126
64	0.760	1425.5100	0.7015
65	0.757	1447.7900	0.6907
66	0.754	1470.0600	0.6802
67	0.750	1492.3300	0.6701
68	0.746	1514.6100	0.6602
69	0.742	1536.8800	0.6507
70	0.738	1559.1500	0.6414
71	0.735	1581.4300	0.6323
72	0.732	1603.7000	0.6236
73	0.730	1625.9800	0.6150
74	0.728	1648.2500	0.6067
75	0.726	1670.5200	0.5986
76	0.725	1692.8000	0.5907
77	0.723	1715.0700	0.5831
78	0.722	1737.3400	0.5756
79	0.720	1759.6200	0.5683
80	0.717	1781.8900	0.5612
81	0.713	1804.1600	0.5543
82	0.707	1826.4400	0.5475
83	0.700	1848.7100	0.5409
84	0.691	1870.9900	0.5345
85	0.682	1893.2600	0.5282
86	0.671	1915.5300	0.5220
87	0.660	1937.8100	0.5160
88	0.650	1960.0800	0.5102
89	0.639	1982.3500	0.5045
90	0.630	2004.6300	0.4988
91	0.621	2026.9000	0.4934
92	0.614	2049.1700	0.4880
93	0.608	2071.4500	0.4828
94	0.602	2093.7200	0.4776
95	0.597	2116.0000	0.4726
96	0.593	2138.2700	0.4677

97	0.589	2160.5400	0.4628
98	0.586	2182.8200	0.4581
99	0.584	2205.0900	0.4535
100	0.581	2227.3600	0.4490
101	0.578	2249.6400	0.4445
102	0.575	2271.9100	0.4402
103	0.572	2294.1800	0.4359
104	0.569	2316.4600	0.4317
105	0.566	2338.7300	0.4276
106	0.564	2361.0000	0.4235
107	0.563	2383.2800	0.4196
108	0.563	2405.5500	0.4157
109	0.564	2427.8300	0.4119
110	0.565	2450.1000	0.4081
111	0.568	2472.3700	0.4045
112	0.571	2494.6500	0.4009
113	0.575	2516.9200	0.3973
114	0.578	2539.1900	0.3938
115	0.580	2561.4700	0.3904
116	0.580	<u>2583.7400</u>	0.3870
117	0.578	2606.0100	0.3837
118	0.574	2628.2900	0.3805
119	0.567	2650.5600	0.3773
120	0.559	2672.8400	0.3741
121	0.548	2695.1100	0.3710
122	0.536	2717.3800	0.3680
123	0.522	2739.6600	0.3650
124	0.510	2761.9300	0.3621
125	0.499	2784.2000	0.3592
126	0.489	2806.4800	0.3563
127	0.481	2828.7500	0.3535
128	0.477	2851.0300	0.3508
129	0.474	2873.3000	0.3480
130	0.476	2895.5700	0.3454
131	0.480	2917.8500	0.3427
132	0.488	2940.1200	0.3401
133	0.498	2962.3900	0.3376
134	0.509	2984.6700	0.3350
135	0.519	3006.9400	0.3326
136	0.531	3029.2100	0.3301
137	0.543	3051.4900	0.3277
138	0.557	3073.7600	0.3253
139	0.572	3096.0400	0.3230
140	0.587	3118.3100	0.3207
141	0.600	3140.5800	0.3184
142	0.612	3162.8600	0.3162
143	0.624	3185.1300	0.3140
144	0.637	3207.4000	0.3118
145	0.652	3229.6800	0.3096
146	0.669	3251.9500	0.3075
147	0.690	3274.2200	0.3054
148	0.714	3296.5000	0.3034
149	0.740	3318.7700	0.3013
150	0.768	3341.0500	0.2993
151	0.795	3363.3200	0.2973
152	0.823	3385.5900	0.2954
153	0.848	3407.8700	0.2934
154	0.870	3430.1400	0.2915
155	0.890	3452.4100	0.2897
156	0.910	3474.6900	0.2878
157	0.929	3496.9600	0.2860
158	0.946	3519.2300	0.2842
159	0.961	3541.5100	0.2824
160	0.972	3563.7800	0.2806
161	0.980	3586.0500	0.2789
162	0.984	3608.3300	0.2771

163	0.986	3630.6000	0.2754
164	0.985	3652.8800	0.2738
165	0.982	3675.1500	0.2721
166	0.979	3697.4200	0.2705
167	0.975	3719.7000	0.2688
168	0.971	3741.9700	0.2672
169	0.968	3764.2400	0.2657
170	0.965	3786.5200	0.2641
171	0.962	3808.7900	0.2626
172	0.959	3831.0700	0.2610
173	0.957	3853.3400	0.2595
174	0.954	3875.6100	0.2580
175	0.951	3897.8900	0.2565
176	0.948	3920.1600	0.2551
177	0.945	3942.4300	0.2537
178	0.942	3964.7100	0.2522
179	0.939	3986.9800	0.2508
180	0.936	4009.2500	0.2494

1360, (2570), 3630





Acoustic Signature Analysis

Source Data File: B:TEST25

Data Description Parameters

Min	Max	Axis Min	Axis Max	Axis Seg	Label
22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
-1.0000	1.0000	-1.0000	1.0000	0.4000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.976	22.3828	44.6771
2	0.951	44.7656	22.3386
3	0.926	67.1484	14.8924
4	0.900	89.5313	11.1693
5	0.876	111.9140	8.9354
6	0.851	134.2970	7.4462
7	0.830	156.6800	6.3824
8	0.809	179.0630	5.5846
9	0.788	201.4450	4.9641
10	0.768	223.8280	4.4677
11	0.750	246.2110	4.0616
12	0.728	268.5940	3.7231
13	0.704	290.9770	3.4367
14	0.679	313.3590	3.1912
15	0.653	335.7420	2.9785
16	0.645	358.1250	2.7923
17	0.637	380.5080	2.6281
18	0.625	402.8910	2.4821
19	0.611	425.2730	2.3514
20	0.590	447.6560	2.2339
21	0.570	470.0390	2.1275
22	0.546	492.4220	2.0308
23	0.522	514.8050	1.9425
24	0.498	537.1880	1.8615
25	0.476	559.5700	1.7871
26	0.455	581.9530	1.7184
27	0.441	604.3360	1.6547
28	0.428	626.7190	1.5956
29	0.420	649.1020	1.5406
30	0.415	671.4840	1.4892

3			
32	0.406	716.2500	1.3962
33	0.403	738.6330	1.3539
34	0.397	761.0160	1.3140
35	0.394	783.3980	1.2765
36	0.391	805.7810	1.2410
37	0.386	828.1640	1.2075
38	0.388	850.5470	1.1757
39	0.391	872.9300	1.1456
40	0.394	895.3130	1.1169
41	0.397	917.6950	1.0897
42	0.398	940.0780	1.0637
43	0.402	962.4610	1.0390
44	0.402	<u>984.8440</u>	1.0154
45	0.398	<u>1007.2300</u>	0.9928
46	0.395	1029.6100	0.9712
47	0.388	1051.9900	0.9506
48	0.381	1074.3800	0.9308
49	0.381	1096.7600	0.9118
50	0.381	1119.1400	0.8935
51	0.383	1141.5200	0.8760
52	0.387	1163.9100	0.8592
53	0.382	1186.2900	0.8430
54	0.378	1208.6700	0.8274
55	0.376	1231.0500	0.8123
56	0.378	1253.4400	0.7978
57	0.381	1275.8200	0.7838
58	0.382	1298.2000	0.7703
59	0.390	1320.5900	0.7572
60	0.397	1342.9700	0.7446
61	0.400	1365.3500	0.7324
62	0.401	<u>1387.7300</u>	0.7206
63	0.401	<u>1410.1200</u>	0.7092
64	0.397	<u>1432.5000</u>	0.6981
65	0.385	1454.8800	0.6873
66	0.372	1477.2700	0.6769
67	0.359	1499.6500	0.6668
68	0.346	1522.0300	0.6570
69	0.330	1544.4100	0.6475
70	0.310	1566.8000	0.6382
71	0.292	1589.1800	0.6293
72	0.274	1611.5600	0.6205
73	0.257	1633.9500	0.6120
74	0.245	1656.3300	0.6037
75	0.230	1678.7100	0.5957
76	0.221	1701.0900	0.5879
77	0.219	1723.4800	0.5802
78	0.213	1745.8600	0.5728
79	0.206	1768.2400	0.5655
80	0.203	1790.6300	0.5585
81	0.204	1813.0100	0.5516
82	0.207	1835.3900	0.5448
83	0.214	1857.7700	0.5383
84	0.219	1880.1600	0.5319
85	0.229	1902.5400	0.5256
86	0.233	1924.9200	0.5195
87	0.238	1947.3000	0.5135
88	0.240	<u>1969.6900</u>	0.5077
89	0.237	<u>1992.0700</u>	0.5020
90	0.235	2014.4500	0.4964
91	0.235	2036.8400	0.4910
92	0.229	2059.2200	0.4856
93	0.233	2081.6000	0.4804
94	0.232	2103.9800	0.4753
95	0.239	2126.3700	0.4703
96	0.251	<u>2148.7500</u>	0.4654

97	0.245	2171.1300	0.4606
98	0.241	2193.5200	0.4559
99	0.236	2215.9000	0.4513
100	0.222	2238.2800	0.4468
101	0.217	2260.6600	0.4423
102	0.209	2283.0500	0.4380
103	0.207	2305.4300	0.4338
104	0.196	2327.8100	0.4296
105	0.181	2350.2000	0.4255
106	0.160	2372.5800	0.4215
107	0.145	2394.9600	0.4175
108	0.125	2417.3400	0.4137
109	0.119	2439.7300	0.4099
110	0.109	2462.1100	0.4062
111	0.076	2484.4900	0.4025
112	0.060	2506.8800	0.3989
113	0.041	2529.2600	0.3954
114	0.033	2551.6400	0.3919
115	0.028	2574.0200	0.3885
116	0.031	2596.4100	0.3851
117	0.047	2618.7900	0.3819
118	0.070	2641.1700	0.3786
119	0.082	2663.5500	0.3754
120	0.102	2685.9400	0.3723
121	0.112	2708.3200	0.3692
122	0.113	2730.7000	0.3662
123	0.115	2753.0900	0.3632
124	0.093	2775.4700	0.3603
125	0.082	2797.8500	0.3574
126	0.080	2820.2300	0.3546
127	0.077	2842.6200	0.3518
128	0.073	2865.0000	0.3490
129	0.064	2887.3800	0.3463
130	0.071	2909.7700	0.3437
131	0.070	2932.1500	0.3410
132	0.064	2954.5300	0.3385
133	0.050	2976.9100	0.3359
134	0.049	2999.3000	0.3334
135	0.069	3021.6800	0.3309
136	0.102	3044.0600	0.3285
137	0.138	3066.4500	0.3261
138	0.135	3088.8300	0.3237
139	0.129	3111.2100	0.3214
140	0.129	3133.5900	0.3191
141	0.151	3155.9800	0.3169
142	0.177	3178.3600	0.3146
143	0.191	3200.7400	0.3124
144	0.185	3223.1300	0.3103
145	0.145	3245.5100	0.3081
146	0.101	3267.8900	0.3060
147	0.040	3290.2700	0.3039
148	-0.007	3312.6600	0.3019
149	-0.039	3335.0400	0.2998
150	-0.073	3357.4200	0.2978
151	-0.091	3379.8000	0.2959
152	-0.089	3402.1900	0.2939
153	-0.071	3424.5700	0.2920
154	-0.019	3446.9500	0.2901
155	0.017	3469.3400	0.2882
156	0.025	3491.7200	0.2864
157	0.024	3514.1000	0.2846
158	0.030	3536.4800	0.2828
159	0.049	3558.8700	0.2810
160	0.075	3581.2500	0.2792
161	0.106	3603.6300	0.2775
162	0.177	3626.0200	0.2758

163	0.233	3648.4000	0.2741
164	0.273	3670.7800	0.2724
165	0.295	<u>3693.1600</u>	0.2708
166	0.291	3715.5500	0.2691
167	0.249	3737.9300	0.2675
168	0.223	3760.3100	0.2659
169	0.183	3782.7000	0.2644
170	0.156	3805.0800	0.2628
171	0.133	3827.4600	0.2613
172	0.140	3849.8400	0.2598
173	0.146	3872.2300	0.2582
174	0.126	3894.6100	0.2568
175	0.107	3916.9900	0.2553
176	0.093	3939.3800	0.2538
177	0.060	3961.7600	0.2524
178	0.001	3984.1400	0.2510
179	-0.058	4006.5200	0.2496
180	-0.124	4028.9100	0.2482
181	-0.188	4051.2900	0.2468
182	-0.244	4073.6700	0.2455
183	-0.298	4096.0500	0.2441
184	-0.356	4118.4400	0.2428
185	-0.430	4140.8200	0.2415
186	-0.480	4163.2000	0.2402
187	-0.542	4185.5900	0.2389
188	-0.579	4207.9700	0.2376
189	-0.600	4230.3500	0.2364
190	-0.624	4252.7300	0.2351
191	-0.673	4275.1200	0.2339
192	-0.696	4297.5000	0.2327
193	-0.712	4319.8800	0.2315
194	-0.730	4342.2700	0.2303
195	-0.748	4364.6500	0.2291
196	-0.770	4387.0300	0.2279
197	-0.765	4409.4100	0.2268
198	-0.785	4431.8000	0.2256
199	-0.777	4454.1800	0.2245
200	-0.777	4476.5600	0.2234
201	-0.800	4498.9500	0.2223

(570), (400), (2150), 3070, 3700

Acoustic Signature Analysis

Source Data File: B:TEST25

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.998	22.2736	44.8961
2	0.993	44.5473	22.4481
3	0.984	66.8209	14.9654
4	0.974	89.0945	11.2240
5	0.960	111.3680	8.9792
6	0.945	133.6420	7.4827
7	0.928	155.9150	6.4137
8	0.909	178.1890	5.6120
9	0.888	200.4630	4.9885
10	0.865	222.7360	4.4896
11	0.840	245.0100	4.0815
12	0.813	267.2840	3.7413
13	0.786	289.5570	3.4535
14	0.757	311.8310	3.2069
15	0.728	334.1050	2.9931
16	0.700	356.3780	2.8060
17	0.672	378.6520	2.6409
18	0.645	400.9250	2.4942
19	0.620	423.1990	2.3630
20	0.596	445.4730	2.2448
21	0.575	467.7460	2.1379
22	0.556	490.0200	2.0407
23	0.542	512.2940	1.9520
24	0.532	534.5670	1.8707
25	0.527	556.8410	1.7958
26	0.527	579.1140	1.7268
27	0.529	601.3880	1.6628
28	0.533	623.6620	1.6034
29	0.541	645.9350	1.5481

30	0.549	668.2090	1.4965
31	0.559	690.4830	1.4483
32	0.570	712.7560	1.4030
33	0.584	735.0300	1.3605
34	0.600	757.3030	1.3205
35	0.618	779.5770	1.2827
36	0.637	801.8510	1.2471
37	0.656	824.1240	1.2134
38	0.672	846.3980	1.1815
39	0.684	868.6720	1.1512
40	0.691	890.9450	1.1224
41	0.692	<u>913.2190</u>	1.0950
42	0.690	935.4930	1.0690
43	0.685	957.7660	1.0441
44	0.679	980.0400	1.0204
45	0.672	1002.3100	0.9977
46	0.665	1024.5900	0.9760
47	0.657	1046.8600	0.9552
48	0.647	1069.1300	0.9353
49	0.635	1091.4100	0.9162
50	0.623	1113.6800	0.8979
51	0.611	1135.9600	0.8803
52	0.600	1158.2300	0.8634
53	0.592	1180.5000	0.8471
54	0.587	1202.7800	0.8314
55	0.585	1225.0500	0.8163
56	0.586	1247.3200	0.8017
57	0.591	1269.6000	0.7877
58	0.599	1291.8700	0.7741
59	0.607	1314.1400	0.7610
60	0.613	1336.4200	0.7483
61	0.617	1358.6900	0.7360
62	0.620	1380.9700	0.7241
63	0.623	1403.2400	0.7126
64	0.627	1425.5100	0.7015
65	0.632	1447.7900	0.6907
66	0.635	1470.0600	0.6802
67	0.637	1492.3300	0.6701
68	0.638	1514.6100	0.6602
69	0.639	1536.8800	0.6507
70	0.641	1559.1500	0.6414
71	0.644	1581.4300	0.6323
72	0.648	1603.7000	0.6236
73	0.651	1625.9800	0.6150
74	0.655	1648.2500	0.6067
75	0.659	1670.5200	0.5986
76	0.662	1692.8000	0.5907
77	0.663	1715.0700	0.5831
78	0.664	1737.3400	0.5756
79	0.665	<u>1759.6200</u>	0.5683
80	0.664	1781.8900	0.5612
81	0.661	1804.1600	0.5543
82	0.656	1826.4400	0.5475
83	0.649	1848.7100	0.5409
84	0.640	1870.9900	0.5345
85	0.627	1893.2600	0.5282
86	0.613	1915.5300	0.5220
87	0.599	1937.8100	0.5160
88	0.583	1960.0800	0.5102
89	0.569	1982.3500	0.5045
90	0.557	2004.6300	0.4988
91	0.545	2026.9000	0.4934
92	0.537	2049.1700	0.4880
93	0.530	2071.4500	0.4828
94	0.524	2093.7200	0.4776
95	0.518	2116.0000	0.4726

96	0.514	2138.2700	0.4677
97	0.512	2160.5400	0.4628
98	0.511	2182.8200	0.4581
99	0.511	2205.0900	0.4535
100	0.512	2227.3600	0.4490
101	0.513	2249.6400	0.4445
102	0.515	2271.9100	0.4402
103	0.517	2294.1800	0.4359
104	0.519	2316.4600	0.4317
105	0.521	2338.7300	0.4276
106	0.525	2361.0000	0.4235
107	0.528	2383.2800	0.4196
108	0.531	2405.5500	0.4157
109	0.534	2427.8300	0.4119
110	0.537	2450.1000	0.4081
111	0.542	2472.3700	0.4045
112	0.547	2494.6500	0.4009
113	0.553	2516.9200	0.3973
114	0.558	2539.1900	0.3938
115	0.563	2561.4700	0.3904
116	0.566	<u>2583.7400</u>	0.3870
117	0.567	<u>2606.0100</u>	0.3837
118	0.564	2628.2900	0.3805
119	0.558	2650.5600	0.3773
120	0.549	2672.8400	0.3741
121	0.537	2695.1100	0.3710
122	0.523	2717.3800	0.3680
123	0.508	2739.6600	0.3650
124	0.495	2761.9300	0.3621
125	0.481	2784.2000	0.3592
126	0.468	2806.4800	0.3563
127	0.454	2828.7500	0.3535
128	0.443	2851.0300	0.3508
129	0.434	2873.3000	0.3480
130	0.426	2895.5700	0.3454
131	0.422	2917.8500	0.3427
132	0.421	2940.1200	0.3401
133	0.425	2962.3900	0.3376
134	0.431	2984.6700	0.3350
135	0.438	3006.9400	0.3326
136	0.444	3029.2100	0.3301
137	0.448	3051.4900	0.3277
138	0.455	3073.7600	0.3253
139	0.464	3096.0400	0.3230
140	0.474	3118.3100	0.3207
141	0.484	3140.5800	0.3184
142	0.490	3162.8600	0.3162
143	0.495	3185.1300	0.3140
144	0.499	3207.4000	0.3118
145	0.507	3229.6800	0.3096
146	0.519	3251.9500	0.3075
147	0.536	3274.2200	0.3054
148	0.560	3296.5000	0.3034
149	0.589	3318.7700	0.3013
150	0.623	3341.0500	0.2993
151	0.661	3363.3200	0.2973
152	0.700	3385.5900	0.2954
153	0.738	3407.8700	0.2934
154	0.771	3430.1400	0.2915
155	0.802	3452.4100	0.2897
156	0.831	3474.6900	0.2878
157	0.861	3496.9600	0.2860
158	0.889	3519.2300	0.2842
159	0.915	3541.5100	0.2824
160	0.937	3563.7800	0.2806
161	0.956	3586.0500	0.2789

162	0.968	3608.3300	0.2771
163	0.976	3630.6000	0.2754
164	0.980	3652.8800	0.2738
165	0.981	3675.1500	0.2721
166	0.981	<u>3697.4200</u>	0.2705
167	0.981	3719.7000	0.2688
168	0.980	3741.9700	0.2672
169	0.979	3764.2400	0.2657
170	0.978	3786.5200	0.2641
171	0.977	3808.7900	0.2626
172	0.975	3831.0700	0.2610
173	0.972	3853.3400	0.2595
174	0.970	3875.6100	0.2580
175	0.968	3897.8900	0.2565
176	0.968	3920.1600	0.2551
177	0.968	3942.4300	0.2537
178	0.969	3964.7100	0.2522
179	0.969	3986.9800	0.2508
180	0.969	4009.2500	0.2494

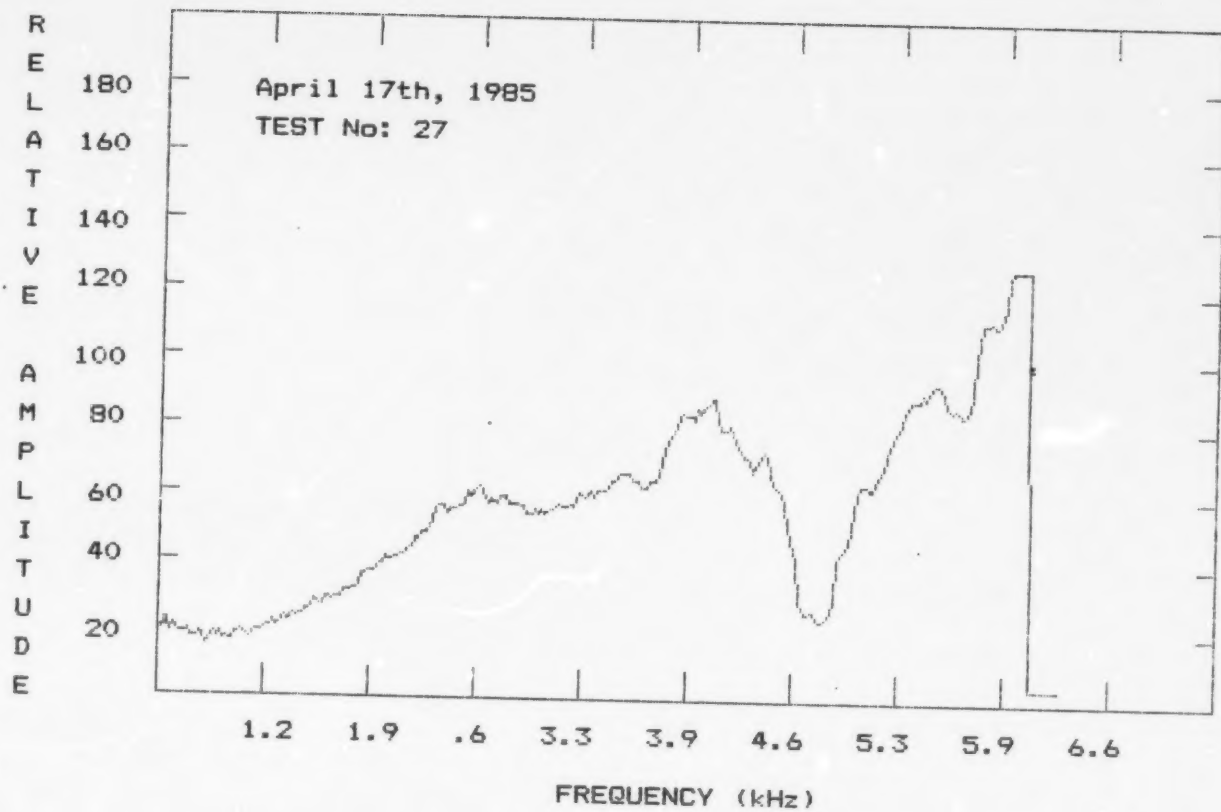
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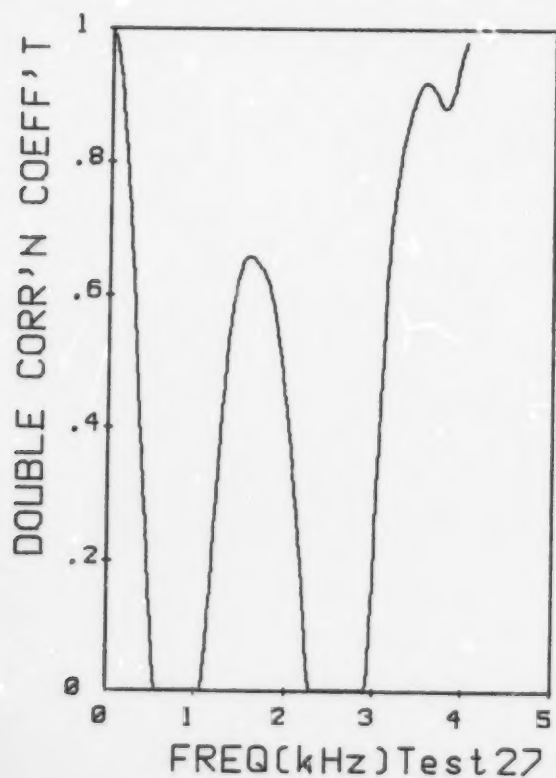
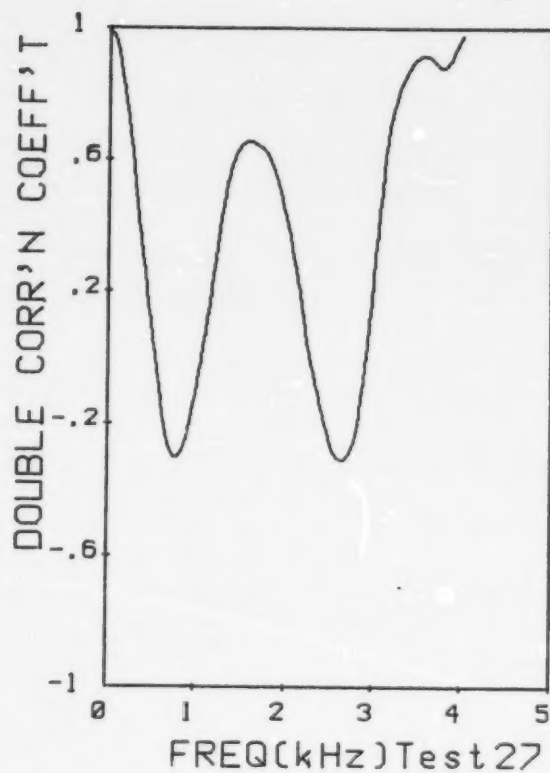
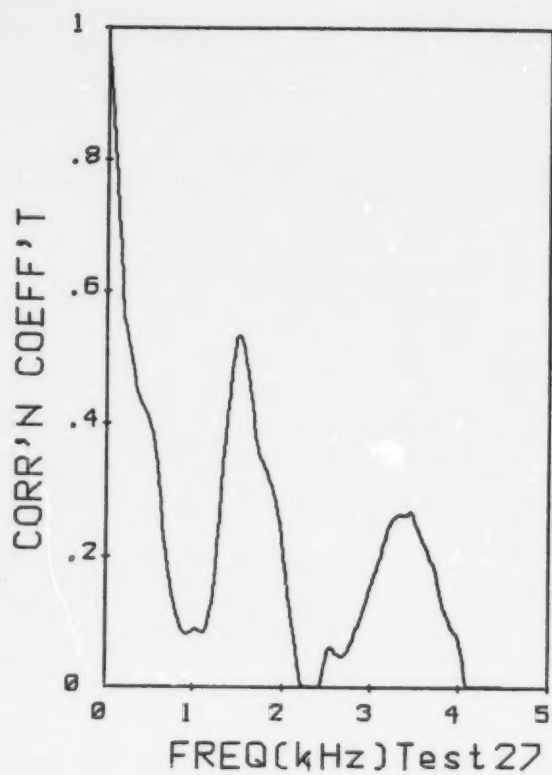
295

$C = 0.34$

$d = 1.75$

$n = 2$





Acoustic Signature Analysis

Source Data File: B:TEST27

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.960	22.3828	44.6771
2	0.917	44.7656	22.3386
3	0.870	67.1484	14.8924
4	0.821	89.5313	11.1693
5	0.770	111.9140	8.9354
6	0.716	134.2970	7.4462
7	0.661	156.6800	6.3824
8	0.609	179.0630	5.5846
9	0.558	201.4450	4.9641
10	0.543	223.8280	4.4677
11	0.527	246.2110	4.0616
12	0.510	268.5940	3.7231
13	0.493	290.9770	3.4367
14	0.475	313.3590	3.1912
15	0.460	335.7420	2.9785
16	0.447	358.1250	2.7923
17	0.437	380.5080	2.6281
18	0.429	402.8910	2.4821
19	0.423	425.2730	2.3514
20	0.416	447.6560	2.2339
21	0.410	470.0390	2.1275
22	0.401	492.4220	2.0308
23	0.393	514.8050	1.9425
24	0.380	537.1880	1.8615
25	0.361	559.5700	1.7871
26	0.336	581.9530	1.7184
27	0.307	604.3360	1.6547
28	0.278	626.7190	1.5956
29	0.250	649.1020	1.5406

30	0.225	671.4840	1.4892
31	0.200	693.8670	1.4412
32	0.178	716.2500	1.3962
33	0.158	738.6330	1.3539
34	0.140	761.0160	1.3140
35	0.125	783.3980	1.2765
36	0.111	805.7810	1.2410
37	0.101	828.1640	1.2075
38	0.092	850.5470	1.1757
39	0.086	872.9300	1.1456
40	0.082	895.3130	1.1169
41	0.079	917.6950	1.0897
42	0.079	940.0780	1.0637
43	0.081	962.4610	1.0390
44	0.084	984.8440	1.0154
45	0.087	1007.2300	0.9928
46	0.089	1029.6100	0.9712
47	0.087	1051.9900	0.9506
48	0.085	1074.3800	0.9308
49	0.082	1096.7600	0.9118
50	0.083	1119.1400	0.8935
51	0.089	1141.5200	0.8760
52	0.099	1163.9100	0.8592
53	0.113	1186.2900	0.8430
54	0.129	1208.6700	0.8274
55	0.148	1231.0500	0.8123
56	0.180	1253.4400	0.7978
57	0.218	1275.8200	0.7838
58	0.260	1298.2000	0.7703
59	0.300	1320.5900	0.7572
60	0.340	1342.9700	0.7446
61	0.377	1365.3500	0.7324
62	0.411	1387.7300	0.7206
63	0.446	1410.1200	0.7092
64	0.480	1432.5000	0.6981
65	0.506	1454.8800	0.6873
66	0.527	1477.2700	0.6769
67	0.534	1499.6500	0.6668
68	0.533	<u>1522.0300</u>	0.6570
69	0.526	1544.4100	0.6475
70	0.513	1566.8000	0.6382
71	0.495	1589.1800	0.6293
72	0.475	1611.5600	0.6205
73	0.455	1633.9500	0.6120
74	0.431	1656.3300	0.6037
75	0.403	1678.7100	0.5957
76	0.378	1701.0900	0.5879
77	0.359	1723.4800	0.5802
78	0.347	1745.8600	0.5728
79	0.341	1768.2400	0.5655
80	0.334	1790.6300	0.5585
81	0.326	1813.0100	0.5516
82	0.318	1835.3900	0.5448
83	0.310	1857.7700	0.5383
84	0.304	1880.1600	0.5319
85	0.294	1902.5400	0.5256
86	0.280	1924.9200	0.5195
87	0.264	1947.3000	0.5135
88	0.246	1969.6900	0.5077
89	0.225	1992.0700	0.5020
90	0.196	2014.4500	0.4964
91	0.167	2036.8400	0.4910
92	0.140	2059.2200	0.4856
93	0.116	2081.6000	0.4804
94	0.094	2103.9800	0.4753
95	0.073	2126.3700	0.4703

96	0.055	2148.7500	0.4654
97	0.036	2171.1300	0.4606
98	0.019	2193.5200	0.4559
99	0.003	2215.9000	0.4513
100	-0.011	2238.2800	0.4468
101	-0.022	2260.6600	0.4423
102	-0.032	2283.0500	0.4380
103	-0.040	2305.4300	0.4338
104	-0.042	2327.8100	0.4296
105	-0.041	2350.2000	0.4255
106	-0.033	2372.5800	0.4215
107	-0.020	2394.9600	0.4175
108	-0.006	2417.3400	0.4137
109	0.012	2439.7300	0.4099
110	0.028	2462.1100	0.4062
111	0.043	2484.4900	0.4025
112	0.054	2506.8800	0.3989
113	0.062	2529.2600	0.3954
114	0.064	(2551.6400)	0.3919
115	0.061	2574.0200	0.3885
116	0.056	2596.4100	0.3851
117	0.052	2618.7900	0.3819
118	0.049	2641.1700	0.3786
119	0.046	2663.5500	0.3754
120	0.048	2685.9400	0.3723
121	0.051	2708.3200	0.3692
122	0.054	2730.7000	0.3662
123	0.060	2753.0900	0.3632
124	0.068	2775.4700	0.3603
125	0.074	2797.8500	0.3574
126	0.082	2820.2300	0.3546
127	0.089	2842.6200	0.3518
128	0.096	2865.0000	0.3490
129	0.102	2887.3800	0.3463
130	0.113	2909.7700	0.3437
131	0.123	2932.1500	0.3410
132	0.135	2954.5300	0.3385
133	0.144	2976.9100	0.3359
134	0.153	2999.3000	0.3334
135	0.163	3021.6800	0.3309
136	0.172	3044.0600	0.3285
137	0.183	3066.4500	0.3261
138	0.194	3088.8300	0.3237
139	0.201	3111.2100	0.3214
140	0.212	3133.5900	0.3191
141	0.220	3155.9800	0.3169
142	0.230	3178.3600	0.3146
143	0.242	3200.7400	0.3124
144	0.249	3223.1300	0.3103
145	0.255	3245.5100	0.3081
146	0.258	3267.8900	0.3060
147	0.261	3290.2700	0.3039
148	0.266	3312.6600	0.3019
149	0.265	3335.0400	0.2998
150	0.265	3357.4200	0.2978
151	0.262	3379.8000	0.2959
152	0.264	3402.1900	0.2939
153	0.267	3424.5700	0.2920
154	0.269	3446.9500	0.2901
155	0.269	3469.3400	0.2882
156	0.262	3491.7200	0.2864
157	0.249	3514.1000	0.2846
158	0.243	3536.4800	0.2828
159	0.237	3558.8700	0.2810
160	0.226	3581.2500	0.2792
161	0.219	3603.6300	0.2775

162	0.214	3626.0200	0.2758
163	0.207	3648.4000	0.2741
164	0.198	3670.7800	0.2724
165	0.192	3693.1600	0.2708
166	0.189	3715.5500	0.2691
167	0.176	3737.9300	0.2675
168	0.161	3760.3100	0.2659
169	0.147	3782.7000	0.2644
170	0.133	3805.0800	0.2628
171	0.123	3827.4600	0.2613
172	0.116	3849.8400	0.2598
173	0.107	3872.2300	0.2582
174	0.102	3894.6100	0.2568
175	0.088	3916.9900	0.2553
176	0.087	3939.3800	0.2538
177	0.083	3961.7600	0.2524
178	0.082	3984.1400	0.2510
179	0.070	4006.5200	0.2496
180	0.056	4028.9100	0.2482
181	0.037	4051.2900	0.2468
182	0.015	4073.6700	0.2455
183	-0.018	4096.0500	0.2441
184	-0.043	4118.4400	0.2428
185	-0.080	4140.8200	0.2415
186	-0.113	4163.2000	0.2402
187	-0.149	4185.5900	0.2389
188	-0.188	4207.9700	0.2376
189	-0.228	4230.3500	0.2364
190	-0.271	4252.7300	0.2351
191	-0.300	4275.1200	0.2339
192	-0.321	4297.5000	0.2327
193	-0.337	4319.8800	0.2315
194	-0.354	4342.2700	0.2303
195	-0.376	4364.6500	0.2291
196	-0.383	4387.0300	0.2279
197	-0.394	4409.4100	0.2268
198	-0.400	4431.8000	0.2256
199	-0.420	4454.1800	0.2245
200	-0.456	4476.5600	0.2234
201	-0.475	4498.9500	0.2223

1510, 3450, (2550)

Acoustic Signature Analysis

Source Data File: B:TEST27

Data Description Parameters Double Correlation

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.997	22.2736	44.8961
2	0.988	44.5473	22.4481
3	0.973	66.8209	14.9654
4	0.952	89.0945	11.2240
5	0.925	111.3680	8.9792
6	0.893	133.6420	7.4827
7	0.856	155.9150	6.4137
8	0.816	178.1890	5.6120
9	0.773	200.4630	4.9885
10	0.726	222.7360	4.4896
11	0.676	245.0100	4.0815
12	0.624	267.2840	3.7413
13	0.571	289.5570	3.4535
14	0.517	311.8310	3.2069
15	0.464	334.1050	2.9931
16	0.410	356.3780	2.8060
17	0.357	378.6520	2.6409
18	0.305	400.9250	2.4942
19	0.253	423.1990	2.3630
20	0.202	445.4730	2.2448
21	0.151	467.7460	2.1379
22	0.100	490.0200	2.0407
23	0.050	512.2940	1.9520
24	-0.000	534.5670	1.8707
25	-0.049	556.8410	1.7958
26	-0.096	579.1140	1.7268
27	-0.140	601.3880	1.6628
28	-0.179	623.6620	1.6034
29	-0.214	645.9350	1.5481
30	-0.244	668.2090	1.4945

30	-0.277	600.2070	1.4700
31	-0.269	690.4830	1.4483
32	-0.289	712.7560	1.4030
33	-0.302	735.0300	1.3605
34	-0.309	757.3030	1.3205
35	-0.311	779.5770	1.2827
36	-0.307	801.8510	1.2471
37	-0.299	824.1240	1.2134
38	-0.286	846.3980	1.1815
39	-0.270	868.6720	1.1512
40	-0.250	890.9450	1.1224
41	-0.227	913.2190	1.0950
42	-0.202	935.4930	1.0690
43	-0.175	957.7660	1.0441
44	-0.145	980.0400	1.0204
45	-0.115	1002.3100	0.9977
46	-0.081	1024.5900	0.9760
47	-0.046	1046.8600	0.9552
48	-0.008	1069.1300	0.9353
49	0.031	1091.4100	0.9162
50	0.072	1113.6800	0.8979
51	0.115	1135.9600	0.8803
52	0.159	1158.2300	0.8634
53	0.205	1180.5000	0.8471
54	0.251	1202.7800	0.8314
55	0.298	1225.0500	0.8163
56	0.344	1247.3200	0.8017
57	0.387	1269.6000	0.7877
58	0.428	1291.8700	0.7741
59	0.466	1314.1400	0.7610
60	0.501	1336.4200	0.7483
61	0.532	1358.6900	0.7360
62	0.561	1380.9700	0.7241
63	0.585	1403.2400	0.7126
64	0.606	1425.5100	0.7015
65	0.622	1447.7900	0.6907
66	0.635	1470.0600	0.6802
67	0.645	1492.3300	0.6701
68	0.653	1514.6100	0.6602
69	0.657	1536.8800	0.6507
70	0.660	1559.1500	0.6414
71	0.660	1581.4300	0.6323
72	0.659	1603.7000	0.6236
73	0.656	1625.9800	0.6150
74	0.653	1648.2500	0.6067
75	0.649	1670.5200	0.5986
76	0.645	1692.8000	0.5907
77	0.641	1715.0700	0.5831
78	0.636	1737.3400	0.5756
79	0.629	1759.6200	0.5683
80	0.620	1781.8900	0.5612
81	0.610	1804.1600	0.5543
82	0.597	1826.4400	0.5475
83	0.583	1848.7100	0.5409
84	0.566	1870.9900	0.5345
85	0.547	1893.2600	0.5282
86	0.527	1915.5300	0.5220
87	0.504	1937.8100	0.5160
88	0.480	1960.0800	0.5102
89	0.454	1982.3500	0.5045
90	0.427	2004.6300	0.4988
91	0.398	2026.9000	0.4934
92	0.369	2049.1700	0.4880
93	0.337	2071.4500	0.4828
94	0.303	2093.7200	0.4776
95	0.268	2116.0000	0.4726
96	0.230	2138.2700	0.4677

97	0.192	2160.5400	0.4628
98	0.153	2182.8200	0.4581
99	0.114	2205.0900	0.4535
100	0.076	2227.3600	0.4490
101	0.040	2249.6400	0.4445
102	0.005	2271.9100	0.4402
103	-0.027	2294.1800	0.4359
104	-0.057	2316.4600	0.4317
105	-0.084	2338.7300	0.4276
106	-0.110	2361.0000	0.4235
107	-0.136	2383.2800	0.4196
108	-0.160	2405.5500	0.4157
109	-0.185	2427.8300	0.4119
110	-0.209	2450.1000	0.4081
111	-0.231	2472.3700	0.4045
112	-0.252	2494.6500	0.4009
113	-0.270	2516.9200	0.3973
114	-0.286	2539.1900	0.3938
115	-0.299	2561.4700	0.3904
116	-0.308	2583.7400	0.3870
117	-0.314	2606.0100	0.3837
118	-0.317	2628.2900	0.3805
119	-0.318	2650.5600	0.3773
120	-0.316	2672.8400	0.3741
121	-0.311	2695.1100	0.3710
122	-0.303	2717.3800	0.3680
123	-0.292	2739.6600	0.3650
124	-0.279	2761.9300	0.3621
125	-0.260	2784.2000	0.3592
126	-0.237	2806.4800	0.3563
127	-0.207	2828.7500	0.3535
128	-0.170	2851.0300	0.3508
129	-0.126	2873.3000	0.3480
130	-0.077	2895.5700	0.3454
131	-0.023	2917.8500	0.3427
132	0.037	2940.1200	0.3401
133	0.100	2962.3900	0.3376
134	0.168	2984.6700	0.3350
135	0.238	3006.9400	0.3326
136	0.309	3029.2100	0.3301
137	0.379	3051.4900	0.3277
138	0.445	3073.7600	0.3253
139	0.508	3096.0400	0.3230
140	0.564	3118.3100	0.3207
141	0.616	3140.5800	0.3184
142	0.662	3162.8600	0.3162
143	0.701	3185.1300	0.3140
144	0.734	3207.4000	0.3118
145	0.762	3229.6800	0.3096
146	0.785	3251.9500	0.3075
147	0.805	3274.2200	0.3054
148	0.822	3296.5000	0.3034
149	0.838	3318.7700	0.3013
150	0.853	3341.0500	0.2993
151	0.866	3363.3200	0.2973
152	0.878	3385.5900	0.2954
153	0.888	3407.8700	0.2934
154	0.897	3430.1400	0.2915
155	0.904	3452.4100	0.2897
156	0.910	3474.6900	0.2878
157	0.915	3496.9600	0.2860
158	0.919	3519.2300	0.2842
159	0.921	3541.5100	0.2824
160	0.922	3563.7800	0.2806
161	0.921	3586.0500	0.2789
162	0.919	3608.3300	0.2771

162	0.910	3600.6000	0.2771
163	0.914	3630.6000	0.2754
164	0.909	3652.8800	0.2738
165	0.903	3675.1500	0.2721
166	0.896	3697.4200	0.2705
167	0.889	3719.7000	0.2688
168	0.884	3741.9700	0.2672
169	0.882	3764.2400	0.2657
170	0.883	3786.5200	0.2641
171	0.886	3808.7900	0.2626
172	0.892	3831.0700	0.2610
173	0.901	3853.3400	0.2595
174	0.912	3875.6100	0.2580
175	0.926	3897.8900	0.2565
176	0.940	3920.1600	0.2551
177	0.953	3942.4300	0.2537
178	0.965	3964.7100	0.2522
179	0.975	3986.9800	0.2508
180	0.984	4009.2500	0.2494

1530, 3500

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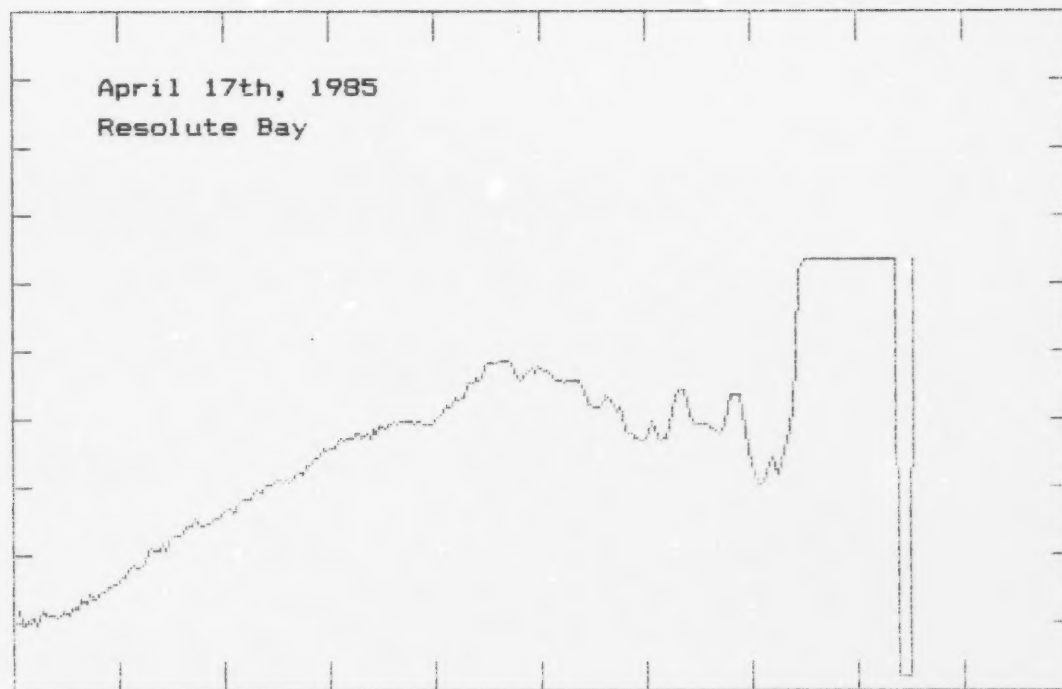
TEST 31

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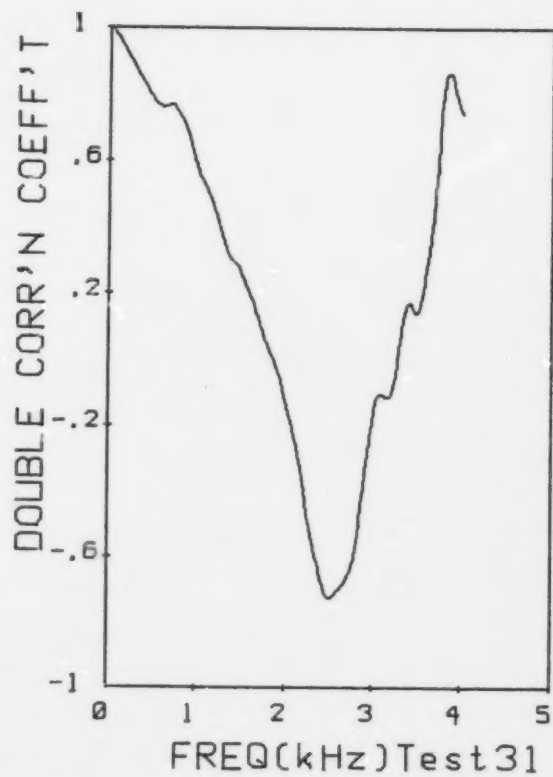
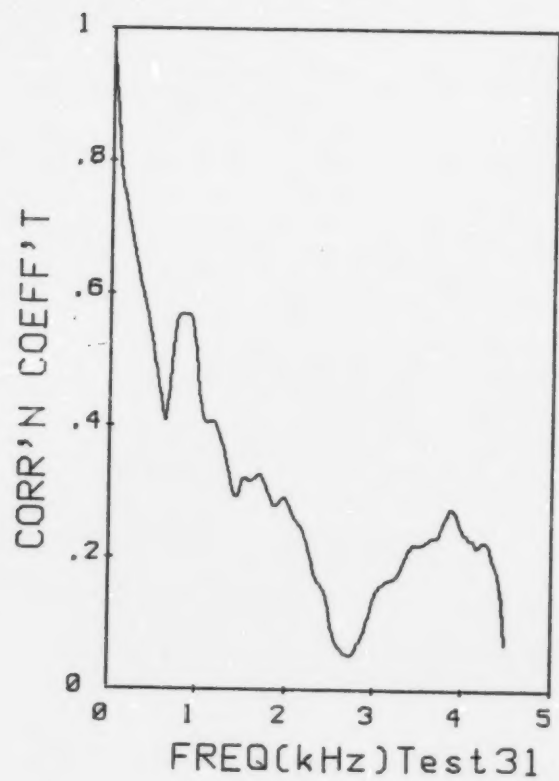
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April 17th, 1985
Resolute Bay



1.2 1.8 2.4 3.0 3.6 4.3 4.9 5.5 6.1

FREQUENCY (kHz)



Acoustic Signature Analysis

Source Data File: B:TEST31

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.963	22.3828	44.6771
2	0.920	44.7656	22.3386
3	0.874	67.1484	14.8924
4	0.826	89.5313	11.1693
5	0.775	111.9140	8.9354
6	0.760	134.2970	7.4462
7	0.745	156.6800	6.3824
8	0.730	179.0630	5.5846
9	0.714	201.4450	4.9641
10	0.697	223.8280	4.4677
11	0.680	246.2110	4.0616
12	0.664	268.5940	3.7231
13	0.648	290.9770	3.4367
14	0.634	313.3590	3.1912
15	0.621	335.7420	2.9785
16	0.608	358.1250	2.7923
17	0.596	380.5080	2.6281
18	0.582	402.8910	2.4821
19	0.567	425.2730	2.3514
20	0.551	447.6560	2.2339
21	0.533	470.0390	2.1275
22	0.515	492.4220	2.0308
23	0.496	514.8050	1.9425
24	0.478	537.1880	1.8615
25	0.460	559.5700	1.7871
26	0.441	581.9530	1.7184
27	0.422	604.3360	1.6547
28	0.405	626.7190	1.5956
29	0.410	649.1020	1.5406
30	0.431	671.4840	1.4893

30	0.451	671.7070	1.4072
31	0.459	693.8670	1.4412
32	0.493	716.2500	1.3962
33	0.533	738.6330	1.3539
34	0.558	761.0160	1.3140
35	0.569	783.3980	1.2765
36	0.570	805.7810	1.2410
37	0.570	828.1640	1.2075
38	0.569	850.5470	1.1757
39	0.567	872.9300	1.1456
40	0.567	895.3130	1.1169
41	0.566	917.6950	1.0897
42	0.557	940.0780	1.0637
43	0.539	962.4610	1.0390
44	0.512	984.8440	1.0154
45	0.481	1007.2300	0.9928
46	0.452	1029.6100	0.9712
47	0.427	1051.9900	0.9506
48	0.410	1074.3800	0.9308
49	0.402	1096.7600	0.9118
50	0.404	1119.1400	0.8935
51	0.407	1141.5200	0.8760
52	0.408	1163.9100	0.8592
53	0.407	1186.2900	0.8430
54	0.401	1208.6700	0.8274
55	0.393	1231.0500	0.8123
56	0.384	1253.4400	0.7978
57	0.375	1275.8200	0.7838
58	0.367	1298.2000	0.7703
59	0.356	1320.5900	0.7572
60	0.343	1342.9700	0.7446
61	0.326	1365.3500	0.7324
62	0.310	1387.7300	0.7206
63	0.296	1410.1200	0.7092
64	0.290	1432.5000	0.6981
65	0.291	1454.8800	0.6873
66	0.301	1477.2700	0.6769
67	0.311	1499.6500	0.6668
68	0.319	1522.0300	0.6570
69	0.320	1544.4100	0.6475
70	0.317	1566.8000	0.6382
71	0.313	1589.1800	0.6293
72	0.314	1611.5600	0.6205
73	0.316	1633.9500	0.6120
74	0.319	1656.3300	0.6037
75	0.324	1678.7100	0.5957
76	0.326	1701.0900	0.5879
77	0.324	1723.4800	0.5802
78	0.316	1745.8600	0.5728
79	0.306	1768.2400	0.5655
80	0.298	1790.6300	0.5585
81	0.290	1813.0100	0.5516
82	0.281	1835.3900	0.5448
83	0.276	1857.7700	0.5383
84	0.278	1880.1600	0.5319
85	0.279	1902.5400	0.5256
86	0.282	1924.9200	0.5195
87	0.286	1947.3000	0.5135
88	0.291	1969.6900	0.5077
89	0.289	1992.0700	0.5020
90	0.283	2014.4500	0.4964
91	0.275	2036.8400	0.4910
92	0.268	2059.2200	0.4856
93	0.260	2081.6000	0.4804
94	0.255	2103.9800	0.4753
95	0.251	2126.3700	0.4703
96	0.248	2148.7500	0.4654

97	0.244	2171.1300	0.4606
98	0.238	2193.5200	0.4559
99	0.231	2215.9000	0.4513
100	0.220	2238.2800	0.4468
101	0.209	2260.6600	0.4423
102	0.196	2283.0500	0.4380
103	0.187	2305.4300	0.4338
104	0.175	2327.8100	0.4296
105	0.166	2350.2000	0.4255
106	0.159	2372.5800	0.4215
107	0.157	2394.9600	0.4175
108	0.151	2417.3400	0.4137
109	0.146	2439.7300	0.4099
110	0.136	2462.1100	0.4062
111	0.124	2484.4900	0.4025
112	0.109	2506.8800	0.3989
113	0.096	2529.2600	0.3954
114	0.084	2551.6400	0.3919
115	0.075	2574.0200	0.3885
116	0.068	2596.4100	0.3851
117	0.061	2618.7900	0.3819
118	0.059	2641.1700	0.3786
119	0.056	2663.5500	0.3754
120	0.052	2685.9400	0.3723
121	0.053	2708.3200	0.3692
122	0.051	2730.7000	0.3662
123	0.053	2753.0900	0.3632
124	0.056	2775.4700	0.3603
125	0.061	2797.8500	0.3574
126	0.065	2820.2300	0.3546
127	0.074	2842.6200	0.3518
128	0.076	2865.0000	0.3490
129	0.082	2887.3800	0.3463
130	0.091	2909.7700	0.3437
131	0.102	2932.1500	0.3410
132	0.113	2954.5300	0.3385
133	0.125	2976.9100	0.3359
134	0.135	2999.3000	0.3334
135	0.145	3021.6800	0.3309
136	0.151	3044.0600	0.3285
137	0.156	3066.4500	0.3261
138	0.159	3088.8300	0.3237
139	0.162	3111.2100	0.3214
140	0.163	3133.5900	0.3191
141	0.165	3155.9800	0.3169
142	0.168	3178.3600	0.3146
143	0.168	3200.7400	0.3124
144	0.169	3223.1300	0.3103
145	0.170	3245.5100	0.3081
146	0.175	3267.8900	0.3060
147	0.176	3290.2700	0.3039
148	0.187	3312.6600	0.3019
149	0.190	3335.0400	0.2998
150	0.200	3357.4200	0.2978
151	0.206	3379.8000	0.2959
152	0.215	3402.1900	0.2939
153	0.216	3424.5700	0.2920
154	0.221	3446.9500	0.2901
155	0.221	3469.3400	0.2882
156	0.221	3491.7200	0.2864
157	0.220	3514.1000	0.2846
158	0.220	3536.4800	0.2828
159	0.220	3558.8700	0.2810
160	0.223	3581.2500	0.2792
161	0.225	3603.6300	0.2775
162	0.228	3626.0100	0.2758

162	0.220	3648.4000	0.2700
163	0.230	3648.4000	0.2741
164	0.233	3670.7800	0.2724
165	0.232	3693.1600	0.2708
166	0.231	3715.5500	0.2691
167	0.235	3737.9300	0.2675
168	0.240	3760.3100	0.2659
169	0.251	3782.7000	0.2644
170	0.256	3805.0800	0.2628
171	0.262	3827.4600	0.2613
172	0.268	3849.8400	0.2598
173	0.277	3872.2300	0.2582
174	0.274	3894.6100	0.2568
175	0.272	3916.9900	0.2553
176	0.266	3939.3800	0.2538
177	0.258	3961.7600	0.2524
178	0.250	3984.1400	0.2510
179	0.244	4006.5200	0.2496
180	0.234	4028.9100	0.2482
181	0.236	4051.2900	0.2468
182	0.231	4073.6700	0.2455
183	0.225	4096.0500	0.2441
184	0.226	4118.4400	0.2428
185	0.225	4140.8200	0.2415
186	0.216	4163.2000	0.2402
187	0.215	4185.5900	0.2389
188	0.221	4207.9700	0.2376
189	0.226	4230.3500	0.2364
190	0.226	4252.7300	0.2351
191	0.224	4275.1200	0.2339
192	0.219	4297.5000	0.2327
193	0.214	4319.8800	0.2315
194	0.201	4342.2700	0.2303
195	0.191	4364.6500	0.2291
196	0.185	4387.0300	0.2279
197	0.179	4409.4100	0.2268
198	0.162	4431.8000	0.2256
199	0.135	4454.1800	0.2245
200	0.100	4476.5600	0.2234
201	0.070	4498.9500	0.2223

810, (1700), (1970), 3880

285.068 , 64.8183
286.5 , 48.0547
287.933

Acoustic Signature Analysis

Source Data File: B:TEST31 Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	-1.0000	1.0000	-1.0000	1.0000	0.4000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4000

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.998	22.2736	44.8961
2	0.993	44.5473	22.4481
3	0.986	66.8209	14.9654
4	0.977	89.0945	11.2240
5	0.967	111.3680	8.9792
6	0.957	133.6420	7.4827
7	0.946	155.9150	6.4137
8	0.935	178.1890	5.6120
9	0.923	200.4630	4.9885
10	0.912	222.7360	4.4896
11	0.901	245.0100	4.0815
12	0.890	267.2840	3.7413
13	0.880	289.5570	3.4535
14	0.870	311.8310	3.2069
15	0.861	334.1050	2.9931
16	0.851	356.3780	2.8060
17	0.841	378.6520	2.6409
18	0.831	400.9250	2.4942
19	0.821	423.1990	2.3630
20	0.810	445.4730	2.2448
21	0.799	467.7460	2.1379
22	0.788	490.0200	2.0407
23	0.779	512.2940	1.9520
24	0.770	534.5670	1.8707
25	0.763	556.8410	1.7958
26	0.759	579.1140	1.7268
27	0.757	601.3880	1.6628
28	0.759	623.6620	1.6034
29	0.763	645.9350	1.5481
30	0.766	668.2090	1.4965

31	0.766	670.4030	1.4400
32	0.767	712.7560	1.4030
33	0.763	735.0300	1.3605
34	0.756	757.3030	1.3205
35	0.748	779.5770	1.2827
36	0.737	801.8510	1.2471
37	0.726	824.1240	1.2134
38	0.713	846.3980	1.1815
39	0.698	868.6720	1.1512
40	0.682	890.9450	1.1224
41	0.664	913.2190	1.0950
42	0.644	935.4930	1.0690
43	0.623	957.7660	1.0441
44	0.601	980.0400	1.0204
45	0.581	1002.3100	0.9977
46	0.563	1024.5900	0.9760
47	0.547	1046.8600	0.9552
48	0.534	1069.1300	0.9353
49	0.521	1091.4100	0.9162
50	0.509	1113.6800	0.8979
51	0.495	1135.9600	0.8803
52	0.480	1158.2300	0.8634
53	0.464	1180.5000	0.8471
54	0.446	1202.7800	0.8314
55	0.428	1225.0500	0.8163
56	0.409	1247.3200	0.8017
57	0.389	1269.6000	0.7877
58	0.369	1291.8700	0.7741
59	0.348	1314.1400	0.7610
60	0.330	1336.4200	0.7483
61	0.314	1358.6900	0.7360
62	0.302	1380.9700	0.7241
63	0.293	1403.2400	0.7126
64	0.287	1425.5100	0.7015
65	0.281	1447.7900	0.6907
66	0.272	1470.0600	0.6802
67	0.260	1492.3300	0.6701
68	0.246	1514.6100	0.6602
69	0.231	1536.8800	0.6507
70	0.216	1559.1500	0.6414
71	0.203	1581.4300	0.6323
72	0.189	1603.7000	0.6236
73	0.175	1625.9800	0.6150
74	0.159	1648.2500	0.6067
75	0.140	1670.5200	0.5986
76	0.120	1692.8000	0.5907
77	0.098	1715.0700	0.5831
78	0.076	1737.3400	0.5756
79	0.057	1759.6200	0.5683
80	0.039	1781.8900	0.5612
81	0.022	1804.1600	0.5543
82	0.009	1826.4400	0.5475
83	-0.003	1848.7100	0.5409
84	-0.016	1870.9900	0.5345
85	-0.031	1893.2600	0.5282
86	-0.048	1915.5300	0.5220
87	-0.069	1937.8100	0.5160
88	-0.094	1960.0800	0.5102
89	-0.121	1982.3500	0.5045
90	-0.148	2004.6300	0.4988
91	-0.173	2026.9000	0.4934
92	-0.197	2049.1700	0.4880
93	-0.219	2071.4500	0.4828
94	-0.244	2093.7200	0.4776
95	-0.271	2116.0000	0.4726
96	-0.301	2138.2700	0.4677
97	-0.334	2160.5400	0.4628

98	-0.371	2182.8200	0.4581
99	-0.408	2205.0900	0.4535
100	-0.445	2227.3600	0.4490
101	-0.481	2249.6400	0.4445
102	-0.515	2271.9100	0.4402
103	-0.547	2294.1800	0.4359
104	-0.575	2316.4600	0.4317
105	-0.601	2338.7300	0.4276
106	-0.626	2361.0000	0.4235
107	-0.650	2383.2800	0.4196
108	-0.673	2405.5500	0.4157
109	-0.695	2427.8300	0.4119
110	-0.713	2450.1000	0.4081
111	-0.725	2472.3700	0.4045
112	-0.731	2494.6500	0.4009
113	-0.732	2516.9200	0.3973
114	-0.727	2539.1900	0.3938
115	-0.721	2561.4700	0.3904
116	-0.713	2583.7400	0.3870
117	-0.705	2606.0100	0.3837
118	-0.697	2628.2900	0.3805
119	-0.691	2650.5600	0.3773
120	-0.683	2672.8400	0.3741
121	-0.674	2695.1100	0.3710
122	-0.663	2717.3800	0.3680
123	-0.648	2739.6600	0.3650
124	-0.629	2761.9300	0.3621
125	-0.604	2784.2000	0.3592
126	-0.573	2806.4800	0.3563
127	-0.536	2828.7500	0.3535
128	-0.494	2851.0300	0.3508
129	-0.445	2873.3000	0.3480
130	-0.393	2895.5700	0.3454
131	-0.341	2917.8500	0.3427
132	-0.288	2940.1200	0.3401
133	-0.237	2962.3900	0.3376
134	-0.189	2984.6700	0.3350
135	-0.151	3006.9400	0.3326
136	-0.123	3029.2100	0.3301
137	-0.107	3051.4900	0.3277
138	-0.100	3073.7600	0.3253
139	-0.102	3096.0400	0.3230
140	-0.107	3118.3100	0.3207
141	-0.113	3140.5800	0.3184
142	-0.116	3162.8600	0.3162
143	-0.113	3185.1300	0.3140
144	-0.101	3207.4000	0.3118
145	-0.079	3229.6800	0.3096
146	-0.049	3251.9500	0.3075
147	-0.006	3274.2200	0.3054
148	0.037	3296.5000	0.3034
149	0.086	3318.7700	0.3013
150	0.126	3341.0500	0.2993
151	0.158	3363.3200	0.2973
152	0.171	3385.5900	0.2954
153	0.175	3407.8700	0.2934
154	0.166	3430.1400	0.2915
155	0.155	3452.4100	0.2897
156	0.145	3474.6900	0.2878
157	0.141	3496.9600	0.2860
158	0.151	3519.2300	0.2842
159	0.174	3541.5100	0.2824
160	0.206	3563.7800	0.2806
161	0.244	3586.0500	0.2789
162	0.283	3608.3300	0.2771

163	0.323	3630.8000	0.2734
164	0.372	3652.8800	0.2738
165	0.430	3675.1500	0.2721
166	0.503	3697.4200	0.2705
167	0.586	3719.7000	0.2688
168	0.672	3741.9700	0.2672
169	0.746	3764.2400	0.2657
170	0.804	3786.5200	0.2641
171	0.846	3808.7900	0.2626
172	0.870	3831.0700	0.2610
173	0.870	3853.3400	0.2595
174	0.857	3875.6100	0.2580
175	0.836	3897.8900	0.2565
176	0.811	3920.1600	0.2551
177	0.787	3942.4300	0.2537
178	0.765	3964.7100	0.2522
179	0.746	3986.9800	0.2508
180	0.739	4009.2500	0.2494

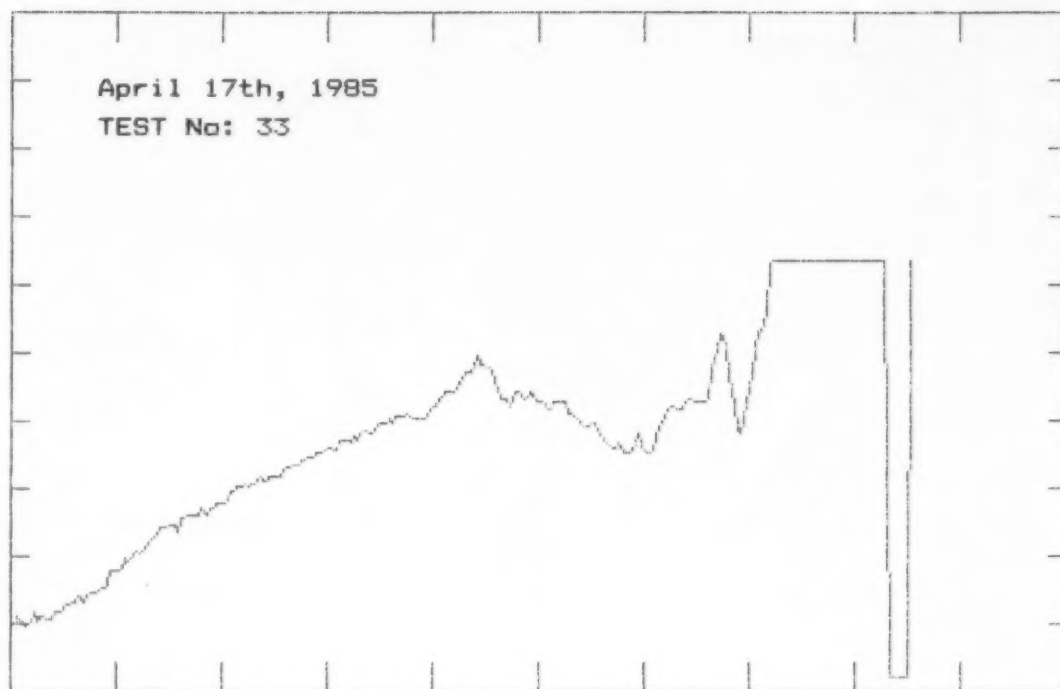
(290), (3080), (3400), 3840

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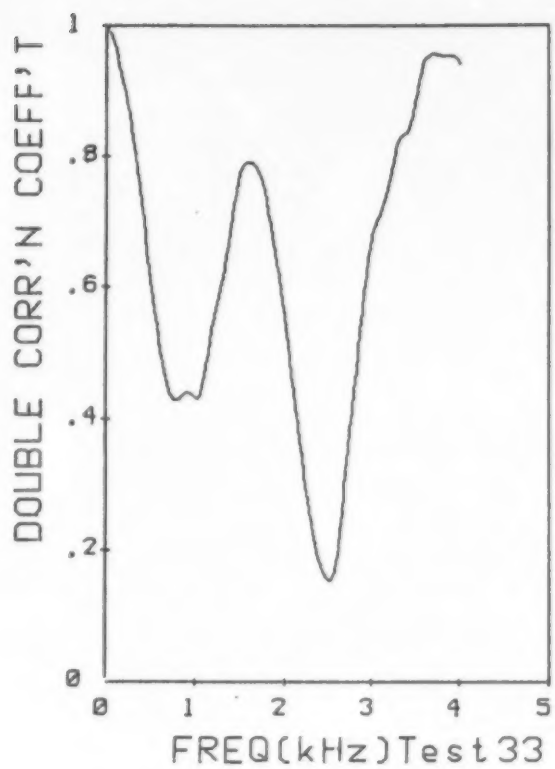
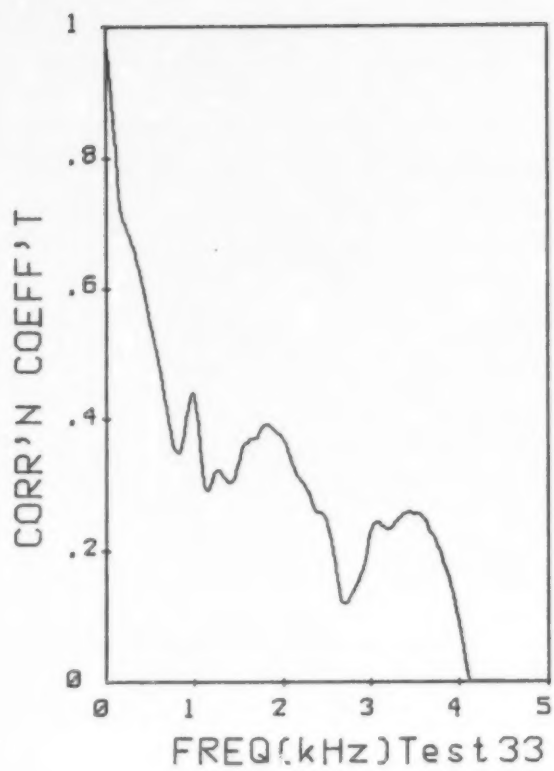
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April 17th, 1985
TEST No: 33



1.2 1.8 2.4 3.0 3.6 4.3 4.9 5.5 6.1

FREQUENCY (kHz)



Acoustic Signature Analysis

Source Data File: B:TEST33

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
	22.0000	4499.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0

Filter Type: No Filter Selected

Filter Value: 0

Correlation Analysis Step (Hz): 4500

Number of Original Data Points: 256

Number of Linearly Interpolated Points: 64

List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.967	22.3828	44.6771
2	0.930	44.7656	22.3386
3	0.891	67.1484	14.8924
4	0.850	89.5313	11.1693
5	0.808	111.9140	8.9354
6	0.766	134.2970	7.4462
7	0.722	156.6800	6.3824
8	0.713	179.0630	5.5846
9	0.704	201.4450	4.9641
10	0.695	223.8280	4.4677
11	0.687	246.2110	4.0616
12	0.678	268.5940	3.7231
13	0.669	290.9770	3.4367
14	0.659	313.3590	3.1912
15	0.648	335.7420	2.9785
16	0.636	358.1250	2.7923
17	0.624	380.5080	2.6281
18	0.610	402.8910	2.4821
19	0.597	425.2730	2.3514
20	0.584	447.6560	2.2339
21	0.571	470.0390	2.1275
22	0.558	492.4220	2.0308
23	0.545	514.8050	1.9425
24	0.531	537.1880	1.8615
25	0.516	559.5700	1.7871
26	0.501	581.9530	1.7184
27	0.484	604.3360	1.6547
28	0.468	626.7190	1.5956
29	0.451	649.1020	1.5406

30	0.433	671.4840	1.4892
31	0.415	693.8670	1.4412
32	0.396	716.2500	1.3962
33	0.376	738.6330	1.3539
34	0.357	761.0160	1.3140
35	0.350	783.3980	1.2765
36	0.348	805.7810	1.2410
37	0.346	828.1640	1.2075
38	0.347	850.5470	1.1757
39	0.357	872.9300	1.1456
40	0.376	895.3130	1.1169
41	0.400	917.6950	1.0897
42	0.418	940.0780	1.0637
43	0.432	962.4610	1.0390
44	0.440	984.8440	1.0154
45	0.436	1007.2300	0.9928
46	0.416	1029.6100	0.9712
47	0.388	1051.9900	0.9506
48	0.354	1074.3800	0.9308
49	0.324	1096.7600	0.9118
50	0.300	1119.1400	0.8935
51	0.290	1141.5200	0.8760
52	0.290	1163.9100	0.8592
53	0.296	1186.2900	0.8430
54	0.305	1208.6700	0.8274
55	0.315	1231.0500	0.8123
56	0.321	1253.4400	0.7978
57	0.322	1275.8200	0.7838
58	0.317	1298.2000	0.7703
59	0.313	1320.5900	0.7572
60	0.309	1342.9700	0.7446
61	0.305	1365.3500	0.7324
62	0.301	1387.7300	0.7206
63	0.301	1410.1200	0.7092
64	0.304	1432.5000	0.6981
65	0.310	1454.8800	0.6873
66	0.317	1477.2700	0.6769
67	0.328	1499.6500	0.6668
68	0.341	1522.0300	0.6570
69	0.353	1544.4100	0.6475
70	0.361	1566.8000	0.6382
71	0.364	1589.1800	0.6293
72	0.366	1611.5600	0.6205
73	0.369	1633.9500	0.6120
74	0.370	1656.3300	0.6037
75	0.372	1678.7100	0.5957
76	0.372	1701.0900	0.5879
77	0.374	1723.4800	0.5802
78	0.382	1745.8600	0.5728
79	0.388	1768.2400	0.5655
80	0.391	1790.6300	0.5585
81	0.392	1813.0100	0.5516
82	0.391	1835.3900	0.5448
83	0.389	1857.7700	0.5383
84	0.385	1880.1600	0.5319
85	0.382	1902.5400	0.5256
86	0.378	1924.9200	0.5195
87	0.376	1947.3000	0.5135
88	0.373	1969.6900	0.5077
89	0.369	1992.0700	0.5020
90	0.364	2014.4500	0.4964
91	0.361	2036.8400	0.4910
92	0.352	2059.2200	0.4856
93	0.341	2081.6000	0.4804
94	0.332	2103.9800	0.4753
95	0.323	2126.3700	0.4703

96	0.316	2148.7500	0.4654
97	0.312	2171.1300	0.4606
98	0.307	2193.5200	0.4559
99	0.303	2215.9000	0.4513
100	0.299	2238.2800	0.4468
101	0.294	2260.6600	0.4423
102	0.287	2283.0500	0.4380
103	0.280	2305.4300	0.4338
104	0.274	2327.8100	0.4296
105	0.267	2350.2000	0.4255
106	0.260	2372.5800	0.4215
107	0.256	2394.9600	0.4175
108	0.257	2417.3400	0.4137
109	0.256	2439.7300	0.4099
110	0.254	2462.1100	0.4062
111	0.247	2484.4900	0.4025
112	0.240	2506.8800	0.3989
113	0.228	2529.2600	0.3954
114	0.213	2551.6400	0.3919
115	0.194	2574.0200	0.3885
116	0.176	2596.4100	0.3851
117	0.153	2618.7900	0.3819
118	0.138	2641.1700	0.3786
119	0.127	2663.5500	0.3754
120	0.120	2685.9400	0.3723
121	0.119	2708.3200	0.3692
122	0.120	2730.7000	0.3662
123	0.123	2753.0900	0.3632
124	0.133	2775.4700	0.3603
125	0.139	2797.8500	0.3574
126	0.143	2820.2300	0.3546
127	0.149	2842.6200	0.3518
128	0.155	2865.0000	0.3490
129	0.164	2887.3800	0.3463
130	0.173	2909.7700	0.3437
131	0.184	2932.1500	0.3410
132	0.198	2954.5300	0.3385
133	0.213	2976.9100	0.3359
134	0.225	2999.3000	0.3334
135	0.237	3021.6800	0.3309
136	0.243	3044.0600	0.3285
137	0.245	3066.4500	0.3261
138	0.245	3088.8300	0.3237
139	0.242	3111.2100	0.3214
140	0.237	3133.5900	0.3191
141	0.236	3155.9800	0.3169
142	0.232	3178.3600	0.3146
143	0.232	3200.7400	0.3124
144	0.234	3223.1300	0.3103
145	0.236	3245.5100	0.3081
146	0.240	3267.8900	0.3060
147	0.246	3290.2700	0.3039
148	0.250	3312.6600	0.3019
149	0.252	3335.0400	0.2998
150	0.254	3357.4200	0.2978
151	0.258	3379.8000	0.2959
152	0.260	3402.1900	0.2939
153	0.262	3424.5700	0.2920
154	0.259	3446.9500	0.2901
155	0.256	3469.3400	0.2882
156	0.256	3491.7200	0.2864
157	0.259	3514.1000	0.2846
158	0.259	3536.4800	0.2828
159	0.257	3558.8700	0.2810
160	0.252	3581.2500	0.2792
161	0.250	3603.6300	0.2775

162	0.247	3626.0200	0.2758
163	0.242	3648.4000	0.2741
164	0.234	3670.7800	0.2724
165	0.227	3693.1600	0.2708
166	0.224	3715.5500	0.2691
167	0.218	3737.9300	0.2675
168	0.210	3760.3100	0.2659
169	0.202	3782.7000	0.2644
170	0.195	3805.0800	0.2628
171	0.184	3827.4600	0.2613
172	0.175	3849.8400	0.2598
173	0.168	3872.2300	0.2582
174	0.159	3894.6100	0.2568
175	0.147	3916.9900	0.2553
176	0.135	3939.3800	0.2538
177	0.122	3961.7600	0.2524
178	0.110	3984.1400	0.2510
179	0.093	4006.5200	0.2496
180	0.075	4028.9100	0.2482
181	0.054	4051.2900	0.2468
182	0.035	4073.6700	0.2455
183	0.012	4096.0500	0.2441
184	-0.011	4118.4400	0.2428
185	-0.035	4140.8200	0.2415
186	-0.052	4163.2000	0.2402
187	-0.074	4185.5900	0.2389
188	-0.092	4207.9700	0.2376
189	-0.106	4230.3500	0.2364
190	-0.119	4252.7300	0.2351
191	-0.135	4275.1200	0.2339
192	-0.146	4297.5000	0.2327
193	-0.160	4319.8800	0.2315
194	-0.168	4342.2700	0.2303
195	-0.193	4364.6500	0.2291
196	-0.217	4387.0300	0.2279
197	-0.243	4409.4100	0.2268
198	-0.271	4431.8000	0.2256
199	-0.303	4454.1800	0.2245
200	-0.327	4476.5600	0.2234
201	-0.356	4498.9500	0.2223

Acoustic Signature Analysis

Source Data File: B:TEST33 Double Correlation

Data Description Parameters

	Min	Max	Axis Min	Axis Max	Axis Seg	Label
X	22.0000	4009.0000	27.0000	5000.0000	994.6000	X - Axis
Y	0.0000	1.0000	0.0000	1.0000	0.2000	Y - Axis

Data Processing Parameters

Minimum Amplitude for Data Listing: 0
Filter Type: No Filter Selected Filter Value: 0
Correlation Analysis Step (Hz): 4000
Number of Original Data Points: 256
Number of Linearly Interpolated Points: 64

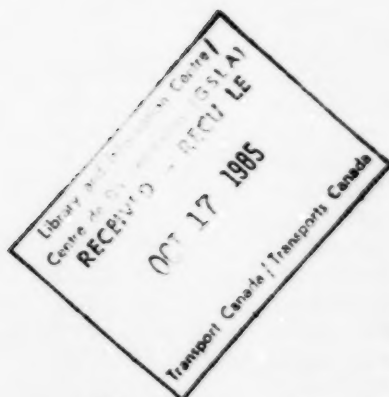
List of Current Data

Element	Amplitude	Frequency	Period (x1000)
1	0.998	22.2736	44.8961
2	0.994	44.5473	22.4481
3	0.986	66.8209	14.9654
4	0.977	89.0945	11.2240
5	0.965	111.3680	8.9792
6	0.953	133.6420	7.4827
7	0.941	155.9150	6.4137
8	0.928	178.1890	5.6120
9	0.915	200.4630	4.9885
10	0.900	222.7360	4.4896
11	0.884	245.0100	4.0815
12	0.866	267.2840	3.7413
13	0.847	289.5570	3.4535
14	0.826	311.8310	3.2069
15	0.803	334.1050	2.9931
16	0.779	356.3780	2.8060
17	0.754	378.6520	2.6409
18	0.729	400.9250	2.4942
19	0.704	423.1990	2.3630
20	0.679	445.4730	2.2448
21	0.655	467.7460	2.1379
22	0.631	490.0200	2.0407
23	0.608	512.2940	1.9520
24	0.585	534.5670	1.8707
25	0.563	556.8410	1.7958
26	0.542	579.1140	1.7268
27	0.521	601.3880	1.6628
28	0.502	623.6620	1.6034

29	0.484	645.9350	1.5481
30	0.467	668.2090	1.4965
31	0.453	690.4830	1.4483
32	0.441	712.7560	1.4030
33	0.433	735.0300	1.3605
34	0.428	757.3030	1.3205
35	0.426	779.5770	1.2827
36	0.426	801.8510	1.2471
37	0.427	824.1240	1.2134
38	0.431	846.3980	1.1815
39	0.435	868.6720	1.1512
40	0.438	890.9450	1.1224
41	0.440	913.2190	1.0950
42	0.439	935.4930	1.0690
43	0.437	957.7660	1.0441
44	0.434	980.0400	1.0204
45	0.431	1002.3100	0.9977
46	0.429	1024.5900	0.9760
47	0.430	1046.8600	0.9552
48	0.436	1069.1300	0.9353
49	0.448	1091.4100	0.9162
50	0.464	1113.6800	0.8979
51	0.482	1135.9600	0.8803
52	0.501	1158.2300	0.8634
53	0.520	1180.5000	0.8471
54	0.538	1202.7800	0.8314
55	0.555	1225.0500	0.8163
56	0.571	1247.3200	0.8017
57	0.586	1269.6000	0.7877
58	0.601	1291.8700	0.7741
59	0.617	1314.1400	0.7610
60	0.633	1336.4200	0.7483
61	0.651	1358.6900	0.7360
62	0.670	1380.9700	0.7241
63	0.690	1403.2400	0.7126
64	0.710	1425.5100	0.7015
65	0.730	1447.7900	0.6907
66	0.749	1470.0600	0.6802
67	0.765	1492.3300	0.6701
68	0.777	1514.6100	0.6602
69	0.786	1536.8800	0.6507
70	0.792	1559.1500	0.6414
71	0.794	1581.4300	0.6323
72	0.795	1603.7000	0.6236
73	0.794	1625.9800	0.6150
74	0.791	1648.2500	0.6067
75	0.788	1670.5200	0.5986
76	0.784	1692.8000	0.5907
77	0.779	1715.0700	0.5831
78	0.771	1737.3400	0.5756
79	0.761	1759.6200	0.5683
80	0.748	1781.8900	0.5612
81	0.733	1804.1600	0.5543
82	0.716	1826.4400	0.5475
83	0.698	1848.7100	0.5409
84	0.678	1870.9900	0.5345
85	0.657	1893.2600	0.5282
86	0.637	1915.5300	0.5220
87	0.617	1937.8100	0.5160
88	0.597	1960.0800	0.5102
89	0.578	1982.3500	0.5045
90	0.557	2004.6300	0.4988
91	0.535	2026.9000	0.4934
92	0.513	2049.1700	0.4880
93	0.490	2071.4500	0.4828
94	0.466	2093.7200	0.4776

95	0.440	2116.0000	0.4726
96	0.415	2138.2700	0.4677
97	0.389	2160.5400	0.4628
98	0.364	2182.8200	0.4581
99	0.340	2205.0900	0.4535
100	0.316	2227.3600	0.4490
101	0.294	2249.6400	0.4445
102	0.273	2271.9100	0.4402
103	0.255	2294.1800	0.4359
104	0.237	2316.4600	0.4317
105	0.222	2338.7300	0.4276
106	0.208	2361.0000	0.4235
107	0.196	2383.2800	0.4196
108	0.184	2405.5500	0.4157
109	0.174	2427.8300	0.4119
110	0.166	2450.1000	0.4081
111	0.159	2472.3700	0.4045
112	0.154	2494.6500	0.4009
113	0.152	2516.9200	0.3973
114	0.153	2539.1900	0.3938
115	0.158	2561.4700	0.3904
116	0.168	2583.7400	0.3870
117	0.184	2606.0100	0.3837
118	0.205	2628.2900	0.3805
119	0.231	2650.5600	0.3773
120	0.260	2672.8400	0.3741
121	0.291	2695.1100	0.3710
122	0.323	2717.3800	0.3680
123	0.356	2739.6600	0.3650
124	0.387	2761.9300	0.3621
125	0.416	2784.2000	0.3592
126	0.446	2806.4800	0.3563
127	0.477	2828.7500	0.3535
128	0.507	2851.0300	0.3508
129	0.538	2873.3000	0.3480
130	0.568	2895.5700	0.3454
131	0.596	2917.8500	0.3427
132	0.623	2940.1200	0.3401
133	0.647	2962.3900	0.3376
134	0.666	2984.6700	0.3350
135	0.681	3006.9400	0.3326
136	0.692	3029.2100	0.3301
137	0.701	3051.4900	0.3277
138	0.709	3073.7600	0.3253
139	0.716	3096.0400	0.3230
140	0.724	3118.3100	0.3207
141	0.733	3140.5800	0.3184
142	0.744	3162.8600	0.3162
143	0.756	3185.1300	0.3140
144	0.769	3207.4000	0.3118
145	0.784	3229.6800	0.3096
146	0.798	3251.9500	0.3075
147	0.811	3274.2200	0.3054
148	0.821	3296.5000	0.3034
149	0.829	3318.7700	0.3013
150	0.834	3341.0500	0.2993
151	0.836	3363.3200	0.2973
152	0.838	3385.5900	0.2954
153	0.840	3407.8700	0.2934
154	0.845	3430.1400	0.2915
155	0.854	3452.4100	0.2897
156	0.868	3474.6900	0.2878
157	0.885	3496.9600	0.2860
158	0.903	3519.2300	0.2842
159	0.919	3541.5100	0.2824
160	0.933	3563.7800	0.2806

CAI	161	0.944	3586.0500	0.2789
DTC847	162	0.951	3608.3300	0.2771
85	163	0.956	3630.6000	0.2754
D26	164	0.958	3652.8800	0.2738
C.2	165	0.960	3675.1500	0.2721
	166	0.960	3697.4200	0.2705
	167	0.960	3719.7000	0.2688
	168	0.958	3741.9700	0.2672
	169	0.957	3764.2400	0.2657
	170	0.956	3786.5200	0.2641
	171	0.956	3808.7900	0.2626
	172	0.956	3831.0700	0.2610
	173	0.956	3853.3400	0.2595
	174	0.956	3875.6100	0.2580
	175	0.957	3897.8900	0.2565
	176	0.957	3920.1600	0.2551
	177	0.956	3942.4300	0.2537
	178	0.954	3964.7100	0.2522
	179	0.949	3986.9800	0.2508
	180	0.942	4009.2500	0.2494



(970), 1600, 3700